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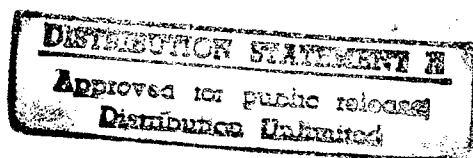
Science & Technology

Science & Technology
USSR: Earth Sciences

19980123 226

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UDC 551.509.313.001.572:551.511:551.576

Use of Dynamic Models for Determining Parameters of Atmosphere With Stratiform Cloud Cover

[Article by V. V. Rozanov and V. S. Kostsov, Physics Scientific Research Institute, Leningrad State University]

[Abstract] A method is proposed for determining the profiles of dynamic parameters of the cloudy atmosphere: vertical velocity of air currents, turbulence coefficient and rate of gravitational settling of cloud droplets. The method is based on the results of measurements of vertical distribution of temperature, humidity and liquid-water content in stratiform clouds. The correlation between the sought-for and measured parameters is stipulated on the basis of a numerical model of cloud cover in the form of L. T. Matveyev invariants. An iteration algorithm is written for solving the model equations in explicit form with allowance for the mean weighted (for mass) rate of settling of cloud droplets. The influence of the rate of settling on the vertical distribution of liquid water content in clouds is analyzed. The inverse problem is solved by invoking regularization methods. The results of numerical experiments for retrieving the profiles of dynamic parameters are given. The influence of different factors on retrieval accuracy is discussed. The method makes it possible to determine the vertical velocity of air currents in stratiform clouds with an accuracy to about 4 mm/s, which is three orders of magnitude greater than radar measurements, two orders of magnitude greater than aircraft methods and an order of magnitude greater than methods based on use of the continuity equation. Figures 2; references: 23 Russian.

UDC 551.576.2.001.57(47+57)

Degree of Mutual Overlapping of Upper-Level Clouds and Lower-Lying Layers Over Territory of USSR

[Article by S. N. Burkovskaya, E. T. Ivanova and I. P. Mazin, professor, Central Aerological Observatory]

[Abstract] Data from regular aircraft sounding of the atmosphere over the USSR for the period 1957-1963 were used in studying variability of the degree of sky coverage by cirrus clouds. A statistical correlation was found between the quantity of cirrus clouds and the probability that they coincide with cloud cover at lower levels. The entire area of the USSR was broken down into eight regions. Over most regions of the country in more than half the cases the sky is free of cirrus clouds; in only two of eight regions does this percentage decrease to 30-40%. In approximately 60-70% of the cases the quantity of cirrus clouds does not exceed 3/10. Over the European USSR cirrus clouds occupy more than 70% of the sky in 15-20% of the cases during the year. In any case over the territory of the USSR, other than the Far East, the probability of sky coverage by cirrus clouds is somewhat increased when clouds of the lower and middle levels are present. This increase can attain 30-50% in situations when cloud coverage is greater than 7/10. Figures 3; references 9: 7 Russian, 2 Western.

UDC 551.521.14

Estimation of Albedo of Earth's Surface and Clouds

[Article by I. M. Baykova, candidate of geographical sciences, State Hydrological Institute]

[Abstract] Empirical relations derived from the processing of satellite measurements were used in estimating albedo of the Earth's surface and clouds; allowance is made for albedo changes caused by variations in solar altitude. Using estimates of the albedo of the underlying surface and the albedo of clouds the formulas make it possible to determine the mean monthly values of albedo of the Earth- atmosphere system (α_s). The computations show that the average annual planetary albedo of the Earth is 30.5%; the contribution of reflectivity of clouds is 22.5%, land 3.6% and ocean 4.4%. A series of tables gives the mean monthly albedos for the ocean, land and Earth's surface as a whole for all months of the year for all latitude zones. A simple formula is derived for relating changes in albedo of the Earth-atmosphere system in absence of a cloud cover and change in surface albedo. This expression for relating α_s to the change in surface albedo is close to that obtained by R. Sess (J. ATMOS. SCI., Vol 35, 1978), although according to this formula the contribution of the high latitudes to the change in α_s is somewhat greater, whereas the contribution of the low latitudes is less than according to the estimates made by Sess. The proposed method can be used both in research related to computations of albedo of the underlying surface and clouds and in estimating changes in climatic conditions different from the present conditions. Figures 2; references 21: 12 Russian, 9 Western.

Theory of Underwater Vision with Arbitrary Radiation Pattern of Radiator or Receiver

[Article by Ye. I. Levin, I. M. Levin, Institute of Oceanography, USSR Academy of Sciences]

[Abstract] In the context of underwater vision, studies prior to this one have derived a correlation between the distribution of signal power in an image and the distribution of reflectivity in the plane of the object observed when the radiation patterns of the radiator and receiver are arbitrary. This article studies the transfer of an underwater image for the most general case, when one of the radiation patterns is narrow, while the other is arbitrary. Equations are derived for the calculation of the energy transfer coefficients of a radiator/object observed/receiver system, back-scatter noise, frequency-contrast characteristics, and contrast for underwater observation and observation through a smooth sea surface. The equations can be used to compute the characteristics determining image quality with arbitrary width of "field" radiation pattern when the narrow "element" pattern is aimed at the center of the systems field of vision. Figures 5; References 8 (Russian).

Influence of Bottom Rereflections on Sound Pressure Level in Water from Source Located in Air

[Article by S. T. Zavtrak, A. I. Zaytsev, A. V. Prokurov, Belorussian State University; Scientific Research Institute of Applied Physics Problems]

[Abstract] A study is made of the influence of bottom rereflection on the level of pressure recorded in water from a source of sound pressure located in the air above the water. It is shown that, because of the way sound travels through the air-water interface, the level of pressure of a wave rereflected from the bottom may be considerably greater than the direct-wave pressure if the horizontal displacement of the receiver is greater than the height of the source above the surface of the water, even under unfavorable conditions for reflection of sound from the bottom. Figures 3; References 8: 4 Russian, 4 Western.

Measurements of Irradiance Attenuation on Narrow Light Beam Axis in Ocean

[Article by A. K. Zakharov, Yu. I. Ventskut, S. V. Vashchenko, Institute of Oceanography, USSR Academy of Sciences]

[Abstract] A new method is suggested for measurement of peak irradiance attenuation E_p on the axis of a narrow beam of light in the ocean with hardware described in a previous work ("Optika morya i atmosfery: Tez. dokl.," Leningrad, Izdatelstvo GOI, 1988, pp 251-252). Data are presented from field measurements performed at sea on the 39th cruise of the r/v *Dmitriy Mendeleyev,* and they are compared with Monte Carlo calculations. The method involves a measurement time of several minutes, a period that is longer than the period of roll of the ship, which enables the beam to hit the receiver, yielding a temporary increase in signal amplitude. The measurements are continued until 3-5 values for E_p are obtained that are within 10% of each other. An averaged attenuation value is used for the E_p on the beam axis. The method was used for the first time ever in actual seawater, to study attenuation with depth right on the axis of a narrow light beam from a pulsed, highly directional light source with a pulse length of 15-20 ns. Measurements were performed in transparent, homogeneous waters in the Philippine Sea at depths of 5-250 m. The data obtained were in good agreement with the Monte Carlo computations. Figures 2; References: 4 Russian.

Scattering of Plane Oblique Incident Wave by Circular Cylindrical Shell

[Article by N. D. Veksler, V. M. Korsunskiy and S. A. Rybak, Cybernetics Institute, Estonian Academy of Sciences; Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] The scattering of a plane oblique incident ray by a circular cylindrical shell is examined. The results of computations are given and an analysis of the frequency dependence and the resonance components of partial modes is presented as a function of scattering of a plane acoustic wave by such a circular cylindrical shell. The direction of propagation of the incident wave forms an angle α with the normal to the longitudinal axis of the shell. In comparison with the problem of scattering of a normally incident wave by a shell, when $\alpha = 0$, in this case two effects are discriminated: the incident wave

excites a torsional wave in the shell; with an increase in α the resonances of each of the waves excited in the shell are displaced in frequency to the right. A formula is given for finding the phase velocity of the peripheral wave from the position of its resonances. The computations were made for a thin (h = 1/512) hollow aluminum shell immersed in water in a narrow frequency range with α = 5 and 10°. It was found that in the considered case the phase velocity of the peripheral wave S_0 is not dependent on α and is equal to c_{pl}, the laminar velocity of the S_0 wave for a plane "dry" layer; the phase velocity of the torsional wave is constant and equal to c_t, the velocity of the transverse wave in linear elasticity theory. Figures 3.

UDC 532.527:534.2

Sound Radiation Accompanying Localized Density Disturbance in Stratified Fluid

[Article by A. N. Kopysov, L. M. Lyamshev and A. T. Skvortsov, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] In a stratified medium turbulence is concentrated in thin interlayers whose thickness is several orders of magnitude less than their horizontal extent and in localized turbulent spots formed as a result of the nonlinear collapse of internal waves. The latter, on collapsing, assume the form of thin interlayers. Such a mechanism for the formation of turbulence in a stratified fluid clearly determines its acoustic radiation, the subject of this research. A spherical disturbance of density was selected as the model of a turbulent spot. Under the influence of stratification such a disturbance collapses, giving rise to a nonstationary hydrodynamic current exciting acoustic oscillations. The acoustic radiation problem as embodied in this model was solved in two stages. In the first stage the parameters of a hydrodynamic current generated by a collapsing spot were computed. Small acoustic disturbances were not taken into account and spot dynamics was described in the approximation of an incompressible fluid. In the second stage the acoustic radiation of the spot was determined from the determined parameters of the hydrodynamic current on the basis of the Lighthill theory. This made it possible to compute the directional diagrams of the acoustic radiation with different Froude and Reynolds numbers. The law of decrease in the total intensity of radiation with time was determined. Figures 4: references 13: 12 Russian, 1 Western.

UDC 551.463

Acoustic-Oceanological Experiment in Lens of Mediterranean Waters in Atlantic Ocean

[Article by N. Ye. Maltsev, K. D. Sabinin and A. V. Furduyev, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] A large and extremely well-expressed inhomogeneity was discovered in the Canary Basin of the Atlantic Ocean in March 1989 during a cruise of the "Akademik Nikolay Andreyev." This was a deep lens of warm and saline Mediterranean waters. The difference in parameters between the nucleus and the ambient waters in the layer 900-1000 m attains 4.6° in temperature, 1.1% in salinity and 18.6 m/s in speed of sound. Full information is given on the hydrological characteristics and the influence of the lens on formation of the acoustic field of the sounding signals and on the spatial characteristics of the field of natural noise in the ocean. The experimental data on signal propagation are compared with computations using a three-dimensional ray model, revealing a good agreement between computed and experimental data. The presence of the lens results in illumination of the geometrical shadow zone, the formation of new convergence regions and a radical change in the angular and spatial-ray structure of the acoustic field. Such data may be useful in solving inverse problems in ocean acoustics: detection of oceanic inhomogeneities from data on the propagation of acoustic signals and occurrence of natural noise fields. Figures 4; references: 4 Russian.

UDC 550.344.094+534.222.2

Elastic Waves in Media With Strong Acoustic Nonlinearity

[Article by V. Ye. Nazarov and L. A. Ostrovskiy, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] Increasing attention is being given to structurally inhomogeneous media in which the degree of nonlinearity is anomalously great relative to that which is related to intermolecular forces. In this case the dependence of stress on strain $\sigma(\varepsilon)$ has a more complex form. Such dependencies are characteristic for media with dislocations, microfissures and other inhomogeneities. The

effects of anomalous acoustic nonlinearity have been observed in the ground and in metals. In such media the effective parameter γ (quadratic nonlinearity) attains values 10^2-10^3. This article discusses the properties of elastic waves in media with strong nonlinearity when the nonlinearity of the equation of state of the medium $\sigma(\varepsilon)$ predominates over the kinematic nonlinearity of the equation of motion. The formation of a shock wave is discussed and its parameters are found for a medium with different elastic moduli. Figures 2; references 13: 12 Russian, 1 Western.

UDC 534

One Approximation of Speed of Sound Within Framework of Layered Model of Ocean

[Article by A. N. Nekrasov, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Approximation of the speed of sound in the ocean by a continuous but not smooth function of depth results in the appearance of features in the acoustic field which are not physically sound: so-called spurious caustics. The introduction of a smooth approximation with discontinuities of the second derivative generates infinitely rapid changes in the computed acoustic field as a function of distance. Their elimination requires introduction of a twice continuously differentiable approximation of the speed of sound. The use of cubic splines for this purpose (S. Moler, et al., J. ACOUST. SOC. AMER., Vol 48, No 3, pp 738- 744, 1970) makes it necessary to solve the ray equations either by numerical integration or by computing elliptical integrals, which is extremely inefficient with respect to use of computer time. Accordingly, an algorithm was written for approximation of the speed of sound in the form of a continuous twice differentiable function of depth which allows computation of ray trajectories in analytical form without the use of any special functions. Examples of computations with this algorithm are given which indicate a very high accuracy in computing ray trajectories. Figure 1; references 4: 1 Russian, 3 Western.

UDC 534+551.463.21

Operation of Horizontal Discrete Array in Randomly Inhomogeneous Ocean

[Article by A. G. Sazontov and V. A. Farfel, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] In sound propagation through a randomly inhomogeneous ocean amplitude-phase fluctuations of the signal arise and therefore the field at the receiving array aperture has an irregular character. The special features of operation of a horizontal linear receiving array in a multimode acoustic waveguide which make possible improved performance are examined. Allowance is made for random inhomogeneities in the ocean medium resulting in a limitation on coherent signal properties. Expressions are derived and analyzed for the most important statistical characteristics of linear arrays in a random ocean. Particular attention is given to the decrease in the gain factor, broadening and dispersion of displacements of the main lobe of mean array response. Specific numerical computations of these effects are made on the assumption that the main source responsible for acoustic signal fluctuation is the random field of internal waves. Figures 2; references 16: 14 Russian, 2 Western.

UDC 534.26

Determination of Directional Characteristics of Acoustic Antenna From Field Measurements in Limited Volume

[Article by I. A. Urusovskiy, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] A method was proposed earlier for computing the directional parameters of radiation of an acoustic antenna on the basis of measurements of its field in a restricted volume. However, the method is applicable only for sound-transparent antennas not causing scattering of the waves incident on them. The same situation prevails in the problem of finding the directional parameters of electromagnetic antennas on the basis of field measurements in a restricted volume. The neglecting of scattering of electromagnetic waves in such a problem is admissible only for bodies of small wave dimensions. This acoustic problem is reexamined with allowance for multiple scatterings of waves by an antenna for the case of a spherical volume with a homogeneous boundary. The spherical surface is assumed to have known reflection coefficients of the spherical harmonics; multiple reflections and scatterings of waves from the bounding sphere and the antenna are taken into account. The coefficients of scattering of spherical harmonics by the antenna are expressed through measurements of a field of sources with a stipulated volume velocity. References: 4 Russian.

UDC 551.465.5

Features of Transformation of Internal Waves in Lomonosov Equatorial Current

[Article by S. I. Badulin, V. M. Vasilenko and N. N. Golenko, Atlantic Division, Oceanology Institute, USSR Academy of Sciences]

[Abstract] A joint analysis was made of measurements of internal waves (IW) and fine thermohaline structure in a test range in the region of the Lomonosov Equatorial Current carried out on the 13th cruise of the "Akademik Mstislav Keldysh" and measurements with autonomous buoy stations in the GATE-74 experiment, making it possible to relate the low intensity of the field of IW in the region of the current axis and dynamic characteristics of IW in a horizontally inhomogeneous ocean. In the zone where the horizontal gradients of current velocity are maximal there was a substantial increase in the vertical scales of fine structure in the pycnocline layer. An interpretation of the mentioned effects is proposed. Due to the nature of the kinematics IW poorly penetrate to the current axis; the axis region is largely cut off from IW energy transport processes in a horizontal direction. In the transitional region there is a zone of strong increase in the amplitudes of IW and their collapse. Figures 6; references 11: 5 Russian, 6 Western.

UDC 551.466.3

Scattering of Surface Waves on Underwater Obstacles

[Article by D. V. Galkin and Ye. N. Pelinovskiy, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The simplest (and quite universal) method for studying the scattering of surface waves on underwater obstacles is based on use of the long-wave approximation, making it possible to investigate the scattered field in the distant zone. This article gives a validation of application of the long-wave approximation to a number of practical problems by a comparison with observational data. A generalization of the method is presented which allows the possibility of refining the results obtained within its framework and solution of a broader class of problems. The proposed approach is illustrated in the example of the two-dimensional problem of the propagation of a linear monochromatic surface wave in a system with one obstacle immersed in a fluid of arbitrary depth. The classes of problems for which the approximations used in the study are correct are indicated. The method allows generalization to the case of structures with several obstacles in a space of any dimensionality. Figure 1; references 10: 4 Russian, 6 Western.

UDC 551.463.5

Theory of Visibility in Sea With Natural Illumination

[Article by I. M. Levin, B. M. Golubitskiy and V. M. Greysukh, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The conditions for applicability of the classical Duntley-Preisendorfer visibility theory are discussed. Formulas are derived for computing true contrast when observing a small object against the background of a water layer in three directions (downward, upward and sideways) in the surface layer of the sea and with depth, supplementing the Duntley-Preisendorfer visibility theory and making it suitable for practical use. The results of computations of contrast and the visibility range show that when making horizontal observations in the upper layers of the sea the contrast and visibility are essentially dependent on the azimuth of the direction of observation relative to the sun. It is shown that the simplified formulas sometimes used for computing the true contrast when making horizontal observations lead to incorrect results. Figures 3; references 16: 10 Russian, 6 Western.

UDC 551.465.5

Influence of Bottom Relief on Stability of Plane-Parallel Current Directed at Angle to Parallel

[Article by G. M. Zhikharev, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The stability of an ocean current stipulated in the form of a plane-parallel flow and directed at an angle to latitude (azonal) was examined earlier using a model of an open ocean with a flat bottom. However, bottom relief of an idealized form can generate so-called orographic instability in a homogeneous zonal current and change the conditions for the development of baroclinic instability. With this taken into account, an analysis was made of various problems relating to the stability of an azonal plane-parallel current over an uneven bottom which may arise when studying the dynamics of mean currents in the open ocean. The following formulation is used as a point of departure. Induced motion is in a two-layer quasigeostrophic model of the ocean situated

on the β-plane. Dimensionless equations are written for the balance of potential vorticity, in which viscous dissipation is not taken into account but in which the effect of Ekman pumping under the influence of wind stress is conserved. The stationary (main) current is bounded by an upper layer. A number of special problems are solved within the framework of this formulation. Figures 3; references 5: 1 Russian, 4 Western.

UDC 551.593.13:551.524.1+53.082.532

Spectra of Stratospheric Temperature Variations Based on Space Observations of Star Scintillations

[Article by A. P. Aleksandrov, G. M. Grechko, A. S. Gurvich, V. Kan, M. Kh. Manarov, A. I. Pakhomov, Yu. V. Romanenko, S. A. Savchenko, S. I. Serova and V. G. Titov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Star scintillations were observed from the "Mir" orbital station. Photocurrent records of scintillations were used in computing scintillation spectra in the altitude range 20-40 km (the temperature inhomogeneities responsible for the observed scintillations constitute highly anisotropic layered formations). The results indicate that observations of star scintillations through the Earth's atmosphere from a space vehicle make it possible to study the statistical structure of the temperature field in the stratosphere. Data are given on earlier unknown features of the behavior of vertical spectra of temperature fluctuations in the range of vertical scales of tens and hundreds of meters where there is a transition from a power-law dependence of density with an exponent -3 to a power-law dependence with the exponent -5. In a considerable range of altitudes and geographical latitudes the form of the spectra of temperature fluctuations changes insignificantly. However, no study was made of the vertical and latitudinal changes in the characteristics of the spectra and their relationship to meteorological conditions and orography. Figures 7; references 25: 15 Western, 10 Russian.

UDC 551.466.3

Vortical Stationary Waves on Shear Flow

[Article by A. A. Abrashkin and D. A. Zenkovich, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] A study was made of the propagation of periodic stationary eddy waves on the surface of an arbitrary (stable) shear current. The perturbations

method in Lagrangian variables was used in deriving equations describing a new class of wave disturbances with an arbitrary distribution of their vorticity along the streamlines. The properties of waves of this class are analyzed in detail down to the third approximation. This revealed that the examined family of wave movements includes as special cases all known types of stationary surface waves of finite amplitude. The velocity of propagation of exponentially vortical disturbances at the surface of a shear current with a linear velocity profile is determined as an example. References 12: 7 Russian, 5 Western.

UDC 551.465.4

Instability of Sverdrup Circulation in Three-Layer and Continuously Stratified Ocean

[Article by A. P. Mirabel and A. S. Monin, Oceanology Institute, USSR Academy of Sciences]

[Abstract] A study was made of the possible instability of such circulations as those around the Azores anticyclone in the Atlantic or around the Hawaiian anticyclone in the Pacific and it is shown that even explosive instability is not impossible. The stability of such a stationary Sverdrup circulation in three-layer and continuously stratified models of the ocean was investigated. Regions of linear instability and nonlinear triad resonant interactions of explosive and decay types could be discriminated on the wave number - Doppler phase velocity of wave disturbances diagram. The same conclusions can be drawn for the instability of disturbances of a Sverdrup circulation in a continuously stratified ocean as for the examined model of a three-layer ocean. Figures 4; references 9: 5 Russian, 4 Western.

UDC 551.466;532.593

Simulation of Internal Wave Propagation in Two-Layer Ocean

[Article by G. A. Khabakhpashev, Thermal Physics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] Although an extensive literature has recently appeared on the propagation of gravitational disturbances in fluids, many questions remain unanswered. Attempts have been made to use evolutionary equations of the Korteweg-de Vries type for clarifying this problem but the field of their applicability is too narrow; they cannot be used in solving problems related to the reflection and interaction of disturbances and there is only a

narrow range of wavelengths in which they can be applied. In order to fill some gaps in research along these lines a study was made of the evolution of plane disturbances of the interface of two incompressible immiscible fluids of different density initially at rest over a horizontal bottom. It is assumed that the time of penetration of the viscous boundary layer to the entire thickness of the fluid is much greater than the characteristic time of the wave process. A wave equation is derived for taking into account the slight nonlinearity of the disturbances, the long-wave contributions of inertia layers and surface tensions, as well as nonstationary friction against the bottom and between layers. The results of a numerical solution of a model integrodifferential equation agree well with experimental data on the damping of solitary internal disturbances. Figures 3; references 23: 14 Russian, 9 Western.

UDC 551.465.41

Evolution of Convection of Salt Fingers in Inhomogeneous Thermocline

[Article by Ye. N. Shcherbakova, Marine Hydrophysics Institute, Ukrainian Academy of Sciences]

[Abstract] A study was made of the evolution of convection of salt fingers in the inhomogeneous thermocline using a numerical scheme developed by S. A. Piacsek and J. Toomre. The following were among the problems investigated. 1) Is the thickness of the interlayer maintained in the initially stipulated form or does it develop in the convection process without dependence on initial conditions?; 2) Is a stationary mode possible in the free interlayer of salt fingers? 3) What are the buoyancy fluxes and the ratio of fluxes in comparison with a laboratory experiment as a function of the density relation? 4) What is the process of mixing in regions with weak gradients adjacent to the interlayer and how is the stepped structure of the thermocline formed? 5) How does computation accuracy influence the integral characteristics of convection? It was discovered that the primary system of convective cells is destroyed and secondary structures are formed in an irregular mode. A quasistationary convection mode was detected and the evolution of buoyancy fluxes was investigated in detail. A good agreement was found between the magnitudes of the fluxes in the stage of well-developed convection and data from laboratory experiments. The region of a high-gradient interlayer with a system of convective cells was not blurred. The onset of formation of the convective layer and the reformation of the thermocline into a stepped structure was observed. Figures 4; references 11: 4 Russian, 7 Western.

UDC 551.463.3

Extinction of Sea Irradiance and Diffuse Reflection Coefficient

[Article by V. M. Greysukh and I. M. Levin, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The Monte Carlo method was used in computing irradiance in the sea and the diffuse reflection coefficient of finite and semi-infinite water layers under directed and diffuse illumination. Simple and quite precise relations are derived for the diffuse reflection coefficient in a broad range of hydrooptical parameters. Computations are made for estimating the accuracy and determining the limits of applicability of known solutions of the radiation transfer equation in quasi-single and self-similar approximations. Since the accuracy of these two approximations is approximately identical, it is preferable to use the simpler quasi-single approximation (cases when the self-similar approximation ensures a higher accuracy are indicated). The errors in the derived semiempirical equations do not exceed 1% or in any case no more than 5%. Figures 4; references 7: 6 Russian, 1 Western.

UDC 551.466.38

Drag Law for Wind Drift in Presence of Waves

[Article by K. D. Kreyman, Limnology Institute, USSR Academy of Sciences, Leningrad]

[Abstract] In natural water bodies drift currents are usually observed in the presence of waves, playing a substantial role in the formation of the internal roughness z_0 of the water surface. A formula is given for the dependence of the internal roughness parameter on the characteristics of waves. On this basis specific forms of the drag law are derived for different situations observable in the course of dynamic interaction between the atmosphere and a water body. Each of the terms in the pertinent equations is discussed. Empirical values of constants were determined in cases where they were previously unknown. The drag law in the presence of wind waves was checked by measurements of the vertical profiles of current velocity in Lake Ladoga and Rybinsk Reservoir in situations with wind speeds up to $7 \times s^{-1}$. (It is precisely with wind speeds greater than 5-6 m x s^{-1} that there is a change in the form of the dependence of the external roughness parameter on the mean speed of the near-surface wind.) The validity of the derived expressions was confirmed. Figure 1; references 10: 6 Russian, 4 Western.

UDC 551.465

Small-Scale Turbulence in Intrathermocline Eddy

[Article by V. D. Pozdynin, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] A probabilistic evaluation was made of small-scale turbulence within the limits of a lens of Mediterranean water discovered at a depth of about 1200 m northwest of the Cape Verde Islands in March- May 1985. Computations were made using data from 17 vertical profiles of the Vaisala-Brunt frequency relating to the depth range 700-1400 m forming a hydrological section taking in the entire extent of the eddy vertically and horizontally. The tabulated results indicate that in most single-time soundings of such an intrathermocline eddy small-scale turbulence is usually absent, but when 10 or more successive soundings are made in a 700-m thickness there is a high probability of registering one turbulent layer. These probabilistic computations indicated that the investigated intrathermocline eddy evidently was characterized by small-scale turbulence with an extremely small number of turbulent layers with low energy levels. Figure 1; references; 2 Russian.

UDC 551.461.7(269+267)

Surface Currents and Thermal Fronts in Southern Indian Ocean

[Article by I. M. Belkin and Yu. A. Romanov, Oceanology Institute imeni P. P. Shirsov, USSR Academy of Sciences, Moscow]

[Abstract] The interrelationship between thermal and kinematic manifestations of the Subtropical Front (STF) and Subantarctic Front (SAF) to the north of the Kerguelen Plateau was studied using data from the 4th and 13th cruises of the "Vityaz." Jet currents of an easterly direction are associated with these two fronts. The surface currents were determined using a satellite navigation system. During January- February 1983 the STF was situated at 41-43.5°S ($T_0 = 11-16.5$°C, gradient T_0' up to 5°C/50 miles, V_{max} 1.7 knot). The SAF was situated at 44.5-45°S ($T_0 = 6-13$°C, T_0' up to 4°C/20 miles, $V_{max} = 4.7$ knots). In April 1987 the STF was at 42°S ($T_0 = 13-17$°C, T_0' up to 4°C/5-10 miles, V_{max} greater than 2 knots). It was found that the SAF has a fine horizontal stepped structure (the number of main steps is 5-6, height of steps about 1°, width of steps 3-8 miles, gradient T_0' up to 1°C/mile). Greatly improved accuracy in the determination of the velocity of surface currents

can be expected with improvements in satellite navigation systems. Figures 3; references 8: 7 Russian, 1 Western.

UDC 551.465.11

Internal Waves Along Northwestern Coast of Africa

[Article by V. M. Vasilenko, A. A. Gaydyukov and V. P. Krasitskiy, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] Internal waves were measured near the northwestern coast of Africa on the 16th cruise of the "Vityaz" in July 1988. Variations of isotherms were measured along the line of towing of a string of temperature transducers with a length of about 100 km. Observations were under extremely stable hydrometeorological conditions. The first segment of towing was over shallow depths (300-500 m), whereas the second was over depths of about 3000 m. The internal waves along the run were usually extremely irregular and for the most part propagated in the form of individual groups. Within the groups the oscillations usually were of a quasiharmonic character and the high-frequency oscillations usually had a lesser intensity and possibly were of a turbulent nature. The intensity of the internal waves was in general low. In deep water internal waves were weaker than in shallow water. In the shallow-water sector formations of the soliton type were discovered which are close in form to Benjamin-Ono solitons. Figures 4; references 6: 4 Russian, 2 Western.

UDC 551.463;551.465

Bottom Layer Current in Azores-Gibraltar Region of Atlantic Ocean

[Article by Ye. A. Kontar, A. B. Grosul and Yu. M. Savostin, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; All-Union Scientific Research Institute for Physical Technical and Radio Engineering Measurements, USSR State Committee for Standards, Moscow Oblast]

[Abstract] Bottom currents in the open ocean were measured synchronously in the Azores-Gibraltar region of the Atlantic Ocean over a period of 13 days (6-19 August) by three bottom stations during the 49th cruise of the "Akademik Kurchatov" in 1988 in an area transitional between the Canary and Iberian abyssal basins with a depth range 3500- 5200 m. The two horizontal components of bottom currents were registered by digital current meters positioned 2.5 m above the ocean floor and extending in a line 83.5 km long. The influence

of bottom relief on the current in the bottom layer of the ocean was ascertained and the results are represented in figures and a table. In the case of station III no currents were registered; this is attributable to the character of local bottom relief at this site. Figures 4; references 2: 1 Russian, 1 Western.

UDC 551.326.7(265.51+265.53+265.546)

Areal Variability of Ice Cover in Far Eastern Seas

[Article by V. A. Petrova, T. V. Saltanova and M. Yu. Trofimov, Pacific Ocean Oceanological Institute]

[Abstract] The intraseasonal and year-to-year variability of ice cover in the areas of Tatar Strait, Sea of Okhotsk and Bering Sea was investigated. The study was based on aerial ice reconnaisances whose data were used in forming time series of mean monthly ice cover data for periods roughly from 1960 to 1985, with a longer series for Tatar Strait. The error in these data is approximately 20%. There is a possible correlation between this variability and oceanic and atmospheric processes characteristic for the northwestern part of the Pacific Ocean and its energy-active zones. An example of prediction of the area of the ice cover of the Sea of Okhotsk is given using an autoregression-integrated moving averages model. The analysis of intraseasonal variability reveals a similarity of its statistical structure in all the studied water areas but with a predominance in the Bering Sea of different mechanisms than in the Sea of Okhotsk and Tatar Strait. Figures 3; references 9: 8 Russian, 1 Western.

UDC 551.463.6(261)

Heat Reserves of Atlantic Ocean Active Layer

[Article by V. G. Snopkov, candidate of geographical sciences, and A. V. Snopkov, Oceanology Institute]

[Abstract] Maps of the heat reserves in the active layer (0-200 m) of the Atlantic Ocean, as well as middle-latitude meridional heat content profiles, were computed and constructed for February and August (the February-August difference gives the amplitude of annual variability). This contrasts with earlier studies of this type in which heat reserves were computed for a season or a year and the entire Atlantic Ocean was involved in this study, not its individual parts. Heat content values were interpolated from five- to one-degree squares, making it possible to detect smaller inhomogeneities in the heat reserve field. Since total heat content is a conservative quantity, averaging of water temperature for a month or season results in an almost identical result. Temperature maps for different depths were based on data from

approximately 115 000 hydrological stations occupied during the period 1872-1972 with data for the horizons 0, 25, 50, 100 and 200 m being used. Heat content computations based on data from the Atlas of the Atlantic and Indian Oceans and from the Levitus atlas, excluding the polar latitudes, give a virtually identical result. Figures 2; references 13: 10 Russian, 3 Western.

UDC 528.22(26):681.883.218

Determining Ship Position From Underwater Geodetic Points

[Article by A. I. Galoshin]

[Abstract] An efficient real-time algorithm is written for determining ship position in ocean regions remote from the land. The algorithm can be used in determining the position of a ship regardless of the number of underwater geodetic points. It is highly effective and simple to apply on a computer because of its recurrent character and in each adjustment stage only one normal correlate equation is solved. The algorithm makes quite complete allowance for the principal factors exerting an influence on the accuracy in determining ship position. Due to flexibility it makes it possible to determine the coordinates of a ship and underwater geodetic points, elements of movement and speed of sound propagation in sea water with increased accuracy at a real time scale using individual measured intervals of travel time of an acoustic signal between the ship and a geodetic point. In data processing it is not the horizontal or slant distances which are used, but the directly measured independent intervals of travel time for an acoustic signal between a ship and underwater geodetic points. Figure 1.

UDC 534.222

Acoustic Sounding of Nonstationary Surfacing Bubble Layers

[Article by S. N. Gurbatov and L. M. Kustov, Gorkiy State University imeni N. I. Lobachevskiy]

[Abstract] The use of acoustic sounding is useful in studying nonstationary bubble layers. Such layers constitute an amplitude-phase screen and during their acoustic sounding it is possible to obtain additional information on the bubble layers. Since the layer is formed by surfacing bubbles of different size and the rate of their surfacing is different, immediately after source activation there will be a vertical spatial distribution of bubbles as a function of their sizes. Larger bubbles will move a greater distance in comparison with smaller bubbles during the same time. In the process of setting-in of a stationary bubble layer three characteristic regions are observed along the z-axis. The first region contains only bubbles whose size is greater than resonance

bubbles; it exerts virtually no influence on the attenuation or speed of sound. The second region contains bubbles whose size is greater than the resonance bubbles and also resonance bubbles and those close to them in size; it exerts an influence on both the attenuation and speed of sound, resulting in curvature of the wave phase front. The third region contains bubbles of all sizes and exerts an influence only on sound attenuation. An experiment was carried out in the experimental basin at Gorkiy State University. The rates of surfacing of bubbles with resonance frequencies from 20 to 163 kHz were determined. The experiment revealed a grouping of bubbles during surfacing. Large bubbles slow down the smaller bubbles; small bubbles, in turn, are entrained by larger bubbles. Information was obtained on how the bubbles leave the source. Large bubbles are held back at the source and are formed from smaller bubbles due to their growth or merging. Small bubbles cannot grow and are detached from the source by the starting large bubbles. Figures 3; references: 11 Russian.

Signal Amplification Under Induced Raman Scattering Conditions in Dispersive Medium

[Article by I. B. Yesipov, V. V. Zosimov and S. Yu. Tretyakova, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] A study was made of the nonlinear interaction of a phase-modulated acoustic wave with a monochromatic pumping wave in a bubble medium. The presence of bubbles considerably changes the wave properties of the medium in which sound propagates. In this case the dispersion relations for sound change, the nonlinear parameter increases and in the presence of a pumping wave the medium acquires active properties, which makes wave front inversion or induced Raman scattering of sound on bubbles possible. Other third-order phenomena also are possible during the interaction of acoustic waves in a medium with bubbles. As a result of interaction of acoustic pumping waves and a signal in a bubble medium under IRS conditions phase modulation of the signal passes with amplification into intensity modulation. The degree of modulation of sound intensity is essentially dependent on the dispersion characteristics of the medium where the interaction of waves occurs. Figures 2; references; 5 Russian.

Zones of Increased Sonification Near Surface of Underwater Sound Channel Open to Bottom in Deep Ocean

[Article by I. B. Burlakova, V. N. Golubev, Yu. V. Petukhov and M. M. Slavinskiy, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The formation of convergence zones is possible in an underwater sound channel. These are most clearly manifested with positioning of the corresponding points far from the channel axis. In underwater sound channels open to the bottom a situation is possible when convergence zones are absent as a result of positioning of the source near the free surface of the ocean where the speed of sound is appreciably greater than the speed of sound at the bottom. In this article it is shown that even in the absence of channel rays in an underwater sound channel open to the bottom the formation of zones of increased sonification is possible when the corresponding points are situated near the surface in an abyssal region of the ocean. This is attributable to the effect of total internal reflection of waves from the bottom in an adequately narrow range of incidence angles. Both experimental and theoretical data are given which indicate that under these conditions zones of increased sonification are formed which in their properties are similar to convergence zones in a channel open to the surface. Figures 3; references: 4 Russian.

Nonlinearity Effects in Internal Waves on Shelf

[Article by A. N. Serebryanyy, Acoustics Institute imeni Akademik N. N. Andreyev]

[Abstract] The parameters of profiles of internal waves of great amplitude which form trains on shallow-water shelves were investigated. The observational data used were collected during the summers of 1977- 1984 in the shelf zones of the Caspian Sea, Black Sea and Sea of Japan. Distributed temperature sensors were used in these measurements. It was found that there is widespread occurrence of nonlinear effects in the characteristic forms of profiles of such waves. Two types of nonlinear distortions were observed: crest-foot asymmetry and asymmetry of the slopes of the leading and

trailing edges of such waves. Estimates of the Ursell parameter indicated a predominance of nonlinearity in most of the trains of strong internal waves observed on shelves. Since trains of strong internal waves are typical and frequent (especially in tidal seas) in shelf zones it is clear that nonlinear internal waves account for a significant percentage of internal waves observed on the shelf. Figures 6; references 19: 15 Russian, 4 Western.

UDC 551.463.2

Registry of Seismoacoustic Oscillations Caused by Internal Waves in Ocean

[Article by A. V. Davydov and G. I. Dolgikh, Pacific Ocean Oceanological Institute, USSR Academy of Sciences]

[Abstract] A study was made of the nature of low-frequency hydroacoustic oscillations generated in the shelf zone in a shallow sea. The results of earlier studies with the registry of such oscillations of natural and artificial origin are reviewed. The magnitude of elastic oscillations of the bottom is greater at the lower frequencies than at higher frequencies. There is an inversely proportional dependence of the amplitude of elastic oscillations on the frequency of the exciting force, suggesting the possibility of using a laser deformograph for registry of weaker low-frequency signals. In the lower-frequency range the main contribution to variations of geophysical fields should be from internal waves which cause elastic oscillations of the bottom. This problem was studied in correlated measurements made in the shelf region of the seasonal thermocline in the Sea of Japan with two distributed temperature sensors and a 105-m laser deformograph installed on the shore of Peter the Great Bay for the purpose of studying the seismoacoustic background. Combined deformograph-distributed temperature sensor measurements were made for 46.5 hours in September 1986. This record indicated the presence of two zones of the most effective transformation of the energy of internal waves into the energy of elastic oscillations of the bottom and that internal waves with periods 9.4 and 6.2 minutes cause elastic oscillations of the bottom in the corresponding periods. It appears that internal waves, due to interaction with bottom relief, generate a strong turbulent velocity field. Some of the energy is transmitted into the bottom and serves as pumping energy for seismoacoustic resonators. Figures 2; references: 7 Russian.

UDC 551.466.81

Generation of Internal Waves in Interaction Between Barotropic Tide and Region of Horizontal Inhomogeneity of Density Field and Bottom Relief

[Article by N. M. Stashchuk and L. V. Cherkesov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] A study was made of the generation of internal waves by a barotropic tide propagating in a uniformly stratified sea through a frontal zone situated over an underwater range or over the continental slope. Computations were made by the Riemann method. The spatial characteristics of the wave fields were analyzed. In comparison with bottom relief irregularities a frontal zone is a relatively weak source of generation of internal tides. Without a frontal zone a barotropic tide, propagating over bottom irregularities, can generate internal waves with an amplitude several times exceeding its own. However, under similar conditions in a region of an isolated frontal zone, situated over an uneven bottom, the amplitudes of the generated waves do not exceed 0.5% of the amplitude of the oncoming barotropic wave. On the other hand, the presence of a frontal zone over an underwater obstacle can substantially change the amplitudes of the generated internal waves. In this case the direction of the density gradient is of great importance. In a downwelling the amplitudes of internal waves on the shelf can be twice as great, whereas in an upwelling less by a factor of 1.5 than in the case of absence of a frontal zone. When there are steep forms of bottom relief a ray zone is formed. Within the ray zone the amplitudes can be twice as great as the amplitude of internal waves in adjacent regions. The presence of a frontal zone over the continental slope changes the structure of the ray zones and the amplitudes of internal waves in it. In the case of an upwelling the transverse dimensions of the ray zone are substantially greater, but the amplitudes in it are considerably less than in the case of absence of a frontal zone. In the case of a downwelling the ray zones are narrowed and the amplitudes of the internal waves in them increase. Figures 4; references 13: 7 Russian, 6 Western.

UDC 551.466.8

Influence of Near Field of Point Source on Generation of Internal Waves

[Article by S. A. Makhortykh, Acoustics Institute]

[Abstract] The behavior of the wave field in a stratified fluid caused by a mass source is investigated. Emphasis is on the role of the potential component of motion in a fluid as a source of vorticity, and accordingly, internal waves. The nonstationary generation of both the potential and eddy components of the field is successively taken into account. Specifically, the generation of disturbances in a stratified fluid which is activated at some moment in time by a point source is examined. The energy characteristics of formation of the field of internal waves are determined. The temporal development of the process of energy transfer from the field potential component to the eddy component is investigated. The role of buoyancy forces arising in the field of potential motions as a source of vorticity in a stratified fluid is demonstrated. The asymptotic forms of the fields of velocity, pressure and energy fluxes over long and short time intervals are ascertained. Figures 2; references: 8 Russian.

UDC 551.466.3

Dynamics of Large-Scale Structure of Wave-Covered Ocean Surface Determined by Processing of Optical Images

[Article by V. Yu. Rayzer, A. V. Smirnov and V. S. Etkin, Space Research Institute, USSR Academy of Sciences]

[Abstract] An aerial survey was made of the northwestern part of the Pacific Ocean in the neighborhood of the Kamchatka trench in the autumn of 1985 for observing different stages of wind wave development. Special digital image analysis algorithms were written for investigating the spatial-statistical parameters of waves and foam coverage dynamics. This analysis revealed that the spatial-statistical metrics of foam formations are a sensitive indicator of ocean surface states during a storm. There is a definite correlation between the form of the spatial spectrum of waves and the characteristics of collapse (foam formation). This correlation is expressed by the dependence W(K/ΔK), where W is the fraction of area covered by foam and K/Δk is wave system "quality." An increase in W due to collapses of the long-wave (20-50 m) components is correlated with a

nonlinear increase in quality (a monochromatization of the spatial spectrum of waves in the energy- bearing maximum region). Figures 7; references 22: 16 Russian, 6 Western.

UDC 551.463.8

Correlations Among Integral Parameters of Sea Light Scattering Functions

[Article by V. I. Mankovskiy and V. Ye. Shemshura, Marine Hydrophysics Institute, Ukrainian Academy of Sciences]

[Abstract] A study of the correlations among the integral characteristics of sea light scattering functions (integral scattering characteristics—ISC) is important because the ISC are frequently used in solving different problems in hydrooptics. This applies in particular to such ISC as the mean asymmetry of the function, mean cosine of the scattering angle, mean angle and mean square of the scattering angle. In an earlier publication the authors derived linear regressions between the mean cosine of the scattering angle, mean angle and mean square of the scattering angle with high correlation coefficients but it was impossible to find the corresponding linear regression between these ISC and the function asymmetry coefficient. New experimental data for various light scattering conditions in oceanic waters, both surface and deep, as well as in fresh-water Lake Baykal, have now been used in computing correlations in the form $Y = A + BX$ among all the considered ISC; these results are tabulated. References: 7 Russian.

UDC 551.465.6

Influence of Current on Dynamics of Surface Film in Field of Internal Wave

[Article by S. A. Yermakov, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The dynamics of surfactants in the field of an internal wave in the presence of a surface current (with which a number of effects important in the interpretation of slicks on the sea surface are associated) was investigated. It is shown that for a train of internal waves whose group velocity is less than the velocity of the surface current there is nonstationary modulation of the concentration of surfactants in front of the train, a "film precursor," or a residual deformation of the film behind the train, a "wake," with an inverse relation of velocities. The degree of modulation of the surfactant concentration increases with approach of the current velocity to

the phase velocity of the wave and is maximal when they are equal ("resonance" condition). These effects are entirely similar to the kinematic effects of transformation of surface waves in the field of an internal wave. It is shown that allowance for a surface current can qualitatively change the nature of redistribution of surfactants over an internal wave and change the pattern of slicks at the sea surface. This must be taken into account when describing in situ observations. Figure 1; references: 4 Russian.

UDC 551.463

Determining Sea Depths by Pulsed Light Sounding Method

[Article by A. P. Ivanov and A. I. Kolesnik, Physics Institute, Belorussian Academy of Sciences, Minsk]

[Abstract] The method for measuring sea depth by short light pulses is based on registry of a signal reflected from the bottom. The method is applicable to such depths where the useful signal is commensurable with system noise (when the signal-to-noise ratio is equal to unity). The limiting depths of detection of the sea floor attainable by the laser sounding method as a function of bottom albedo, optical properties of the water layer, parameters of the radiation source and detector and noise of different types (dark noise, shot noise, noise of the signal propagation channel, noise of background illumination) were determined on the basis of an analysis of the pattern of change of the signal-to-noise ratio registered when determining sea depths by the pulsed light sounding method. Simple formulas are derived for use in engineering computations, optimization and evaluation of the efficiency in operation of specific sounding systems. In pulsed light sounding the depth of bottom detection in some cases can be increased by a factor of 2-2.5 in comparison with visual observation. Figure 1; references: 10 Russian.

UDC 534.231.2

Reverberation in Vector Field of Acoustic Energy Flow Density

[Article by V. P. Dzuba and V. I. Ilichev, academician, Pacific Ocean Oceanological Institute, Far Eastern Department, USSR Academy of Sciences, Vladivostok]

[Abstract] The vector character of the energy flow has important consequences and therefore the differences between reverberation in the field of the vector of energy flow density and reverberation in the intensity field were compared. Convenient expressions were derived for making this comparison. It was found that there is a fundamental difference in possible levels of the reverberation signal. In the case of the intensity field the level can never be equal to zero. It is different in the field of the vector of flow density, where in the presence of an isotropic distribution in the space of scatterers the total flow of scattered acoustic energy is equal to zero. Accordingly, deviations from spatial isotropicity in the distribution of scatterers exert a considerably stronger influence on the reverberation signal in the field of the energy flow vector. In practice this should mean an increase in the signal-to-noise ratio during reverberation in the field of the vector of flow of acoustic energy in comparison with the intensity field. References: 7 Russian.

UDC 551.465.4(265.16)

Water Circulation in Region of Proposed Exploitation of Ferromanganese Nodules in Eastern Tropical Zone of Pacific Ocean

[Article by A. I. Simonov, doctor of geographical sciences (deceased), G. Ya. Shkudova, candidate of geographical sciences, V. B. Lapshin, candidate of physical and mathematical sciences, and A. I. Ushanov, State Oceanographic Institute]

[Abstract] The results of computations of water circulation in the eastern tropical zone of the Pacific Ocean, where the exploitation of ferromanganese nodules is proposed, are described and analyzed. Surface level and current velocities were computed for four quasisynchronous surveys made in different years at 16 horizons in the ocean to depths as great as 3000 m. The approximate area of the research was 10-14°N- 132-134°W; pertinent data were collected by the research ships "Akademik Korolev," "Professor Khromov" and "Okean." In this area there is intensive formation of eddies associated for the most part with the barotropic-baroclinic instability of the Trade Currents. A distinctive feature is a great spatial and temporal variability of the North Trades Current, frontal zones and individual jets of the Inter-Trades Countercurrent. In zones of cyclonic eddies there is strong upwelling of deep waters, but in frontal convergent zones, strong subsidence of waters. The velocities of the maximal vertical movements are at the horizon 30-50 m. The complexity of dynamic structure of waters in the test range and the presence of multiple cyclonic and anticyclonic zones lead to intensified exchange between surface and deep water masses and accordingly a difference in hydrochemical structures and biological productivity; these and other factors considered in the article must be taken into account when developing equipment for use in this region in the commercial exploitation of ferromanganese nodules. Figures 2; references: 8 Russian.

UDC 551.463.6(261.1+265.2)

Recent Climatic Changes in Vertical Thermal Structure of Northern Parts of Atlantic and Pacific Oceans

[Article by D. I. Antonov, State Hydrological Institute]

[Abstract] Archives of water temperature measurements for the period 1957-1981 at standard horizons from 300 to 3000 m were used in obtaining time series of the mean annual water temperature averaged for the northern part of the Atlantic and Pacific Oceans (from the equator to 70 and 60° respectively). For the most part the observed changes in the vertical thermal structure of these oceans in the northern hemisphere can be interpreted as their reaction to changes in the climatic system caused by the global warming process. It is concluded that the decrease in ocean surface temperature (OST) occurring in the 1960's and 1970's caused a decrease in water temperaure in the upper 500-m layer in both oceans. However, the reaction of deeper layers of northern hemisphere oceans to the prolonged increase in OST continuing to at least the mid-1950's to the early 1960's was different. In the Pacific Ocean during the considered 25-year interval there were no substantial changes in thermal structure at depths greater than 500 m. An increase in water temperature in the layer 1200-2000 m in the North Atlantic by 0.1° in 25 years is evidently a response to changes in the climatic system associated with the global warming process. Figures 4; references 14: 4 Russian, 10 Western.

UDC 556.536.2/.3;556.535.6

Bottom Friction Factor Determination for Waves on Current

[Article by I. G. Kantarzhi, candidate of technical sciences, K. I. Shevchenko and M. Shushen, All-Union Scientific Research Institute for Water Supply, Sewer Systems, Hydraulic Structures and Engineering Hydrology]

[Abstract] A physical model making it possible to determine the bottom friction factor (a parameter important in studying the dynamics of sediments) when waves are present on a current was proposed by W. D. Grant, et al. in JGR, Vol 84, No C11, 1979. (The basic content of this model is reviewed.) However, this model required further experimental checking. The model was checked numerically using data published by J. Brevik in COAST. ENG., No 4, 1980, and original data collected by the authors. The term "combined flow" was adopted for a current when surface waves are present. An algorithm is given for computing the bottom friction factor and other characteristics for a combined flow. The results indicate the effectiveness of the proposed algorithm for computing the bottom friction factor and the applicability of the method is demonstrated for studying the onset of sediment transport. Figures 3; references 13: 3 Russian, 10 Western.

UDC 551.466.8

Scattering of Internal Waves in Pycnocline With Local Stratification Impairments

[Article by Ye. V. Yegorov, A. S. Tibilov and V. A. Yakovlev]

[Abstract] The influence of compact density inhomogeneities in the pycnocline on the stability of propagating internal waves was investigated. The shear stability of wave currents was studied in a linear formulation. This was done by the numerical integration of a solution of the problem of scattering of internal waves on density inhomogeneities, expressed in quadratures. Different models of structure of density inhomogeneities were considered. The scattering of internal waves on spots of mixed fluid is accompanied by a considerable (by one- three orders of magnitude) local decrease in the Richardson number for the wave field as a whole. With scattering in completely mixed regions the effect is manifested more strongly than with scattering in stratified spots. Localization of the effect makes it possible to assume that a decrease in the stability of internal waves during interaction with a mixed region may serve as one of the mechanisms ensuring anomalously prolonged existence of turbulent spots in the ocean and in general, one of the mechanisms for maintaining dynamic equilibrium in the internal waves-turbulence system. Figures 3; references 9: 7 Russian, 2 Western.

UDC 551.466

Deviation of Profile of Mean Wind Speed Over Waves From Logarithmic Distribution

[Article by V. K. Makin, Oceanology Institute, USSR Academy of Sciences]

[Abstract] Measurements of the mean wind over monochromatic waves in situ and in wind tunnels usually do not reveal significant deviations of the wind speed profile from a logarithmic distribution characteristic for the layer of constant turbulent flows over a plane rough surface with neutral stratification of the near-water atmospheric layer. This contradicts certain measurements at sea directly over wave crests showing the existence of an appreciable deviation of the wind profile from a logarithmic distribution in the form of a characteristic bend near the surface. The

author explained this effect and the discrepancies in measurement data in an earlier article (OKEANOLOGIYA, Vol 27, No 2, pp 176-183, 1987) on the basis of a nonlinear model of the near-water layer over waves. This phenomenon has now been explored in greater depth. It is shown that the deviation of mean wind speed from a logarithmic distribution is caused by the correlations of wave disturbances of hydrodynamic fields in the air and is an essentially nonlinear effect of wave streamline flow. Quantitative estimates were obtained by solution of the full nonlinear problem. It is shown under what conditions the effect will be observed and when it will be absent. Figures 2; references 11: 7 Russian, 4 Western.

UDC 551.465.5

Acoustic Method for Studying Modal Structure of Internal Waves

[Article by V. Ya. Kogan and V. V. Novotryasov, Pacific Ocean Oceanological Institute, USSR Academy of Sciences]

[Abstract] The possibility of using the acoustic method for research on the modal structure of internal waves was investigated. The research was carried out in the northeastern part of the Philippine Sea, an area with a clearly expressed cycle of variability of hydrophysical fields. The submersible acoustic sounding device used included a device for measuring the scattering of ultrasound at a frequency 0.67 MHz, a device for measuring the speed of sound in a range 1400-1600 m/s with a response 0.01 m/s and a depth sensor operating in the range from 0 to 1000 m with a response 0.3 m and an accuracy +/-2.5 m. The measurement process involved narrowly directed irradiation of the medium by an ultrasonic beam, reception and registry of a signal scattered at a distance 54 cm in a local volume of about 120 cm^3. Acoustic measurements were accompanied by temperature and salinity measurements. The collected data give evidence of the possibility of using the acoustic method for investigating the modal structure of internal waves. However, work by the proposed method is possible only in regions with strong internal waves, such as on the shelf and in tidal seas, in cases of a monotonic change in conservative fields under the influence of these waves. Figures 3; references 9: 8 Russian, 1 Western.

UDC 551.509.3

Simulation of Intraseasonal Low-Frequency Variability of Atmospheric Circulation and Ocean Surface Temperature in Middle Latitudes

[Article by V. P. Dymnikov and M. A. Tolstykh, Computational Mathematics Section, USSR Academy of Sciences]

[Abstract] A study was made of intraseasonal low-frequency variability of atmospheric circulation and surface temperature of the Atlantic Ocean using a joint model of general circulation of the atmosphere and the upper active layer of the Atlantic Ocean. The article describes the structure of the joint model and discusses the results of numerical experiments for simulating winter (January) joint circulation of the atmosphere and the upper layer of the ocean. The model is based on a system of primitive nonlinear equations of atmospheric hydrothermodynamics in Lamb form on a sphere using the vertical σ coordinate. The most correlated structures in the geopotential fields of the 500-mbar surface and ocean surface temperature were defined; these were close to the corresponding structures obtained on the basis of observational data. Figures 6; references 19; 13 Russian, 6 Western.

UDC 551.510.61

Solution of Inverse Problems in Remote Atmospheric Refractometry on Slant Paths

[Article by M. Ye. Gorbunov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Problems in satellite atmospheric tomography are solved based on measurements of the eikonal and refraction in the first order of the theory of perturbations. Such problems are reduced to linear integral equations generalizing equations of the Abel type. An approximation is constructed which is based on the neglecting of inhomogeneities with horizontal scales less than 60 km, making it possible to give the equations the same form as in the case of direct unperturbed rays. Solutions are found using expansions in a full system of functions. These expansions can be useful in constructing regularizing algorithms using a priori information. The accuracy of an evaluation of the locally spherically symmetric atmosphere approximation (LSSA) was tested. Precise formulas are derived for factorization of the inverse operators. An approximate expression is also given for a correcting operator making it possible to write a simple numerical inversion algorithm improving accuracy in comparison with the LSSA approximation with an insignificant increase in expenditures of computer time. Figures 2; references 10: 7 Russian, 3 Western.

UDC 551.521.31

Anomalies of Spectral Transparency in Earth's Atmosphere

[Article by V. V. Lukshin, A. A. Isakov, M. A. Sviridenkov, G. I. Gorchakov and A. S. Smirnov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Previous research has indicated that with a definite atmospheric depth effects are frequently observed which cannot be explained within the framework of current concepts in the field of atmospheric optics. In order to resolve this problem measurements were made of the optical characteristics of aerosol, including measurements of spectral transparency and brightness functions of the circumsolar aureole, accompanied by spectronephelometry of near-surface aerosol. The measurements were made in September-October 1987 near Odessa. The measurements, made in the UV, visible and near-IR spectral regions, revealed a number of special features of spectral transparency: "banded" spectral structure, strong temporal variability, including sporadicity, and intensification of anomalous effects with an increase in air mass. It was found that there is a closure of the Fraunhofer lines in direct solar radiation lines (H and K CaII). The conclusion is drawn that there is atmospheric radiation, not isolated earlier, which is codirected with solar radiation. Figures 5; references 14; 13 Russian, 1 Western.

UDC 551.521.31

Commentary on Article by V. V. Lukshin, A. A. Isakov, M. A. Sviridenkov, G. I. Gorchakov and A. S. Smirnov Entitled 'Spectral Transparency Anomalies in Earth's Atmosphere'

[Article by V. Ye. Pavlov, Astrophysical Institute, Kazakh Academy of Sciences]

[Abstract] This is a commentary on the article cited in the headline, appearing in the same number of this journal (pp 135-140), relating to previously unobserved transformations of Fraunhofer lines in the spectrum of direct solar radiation, increasing with an increase in solar zenith distance. It is noted that if such regular transformations of Fraunhofer lines do exist, they should

have been observed earlier by specialists in the field of solar physics, but it must have escaped their attention. The references to the existence of the anomalous transparency effect seen unconvincing; it could not be detected even in the dry steppes and in high-mountain areas. These and other negative comments are not meant to discredit the soundness of the article, the integrity of the authors and the excellence of the observational apparatus being beyond question. However, the question remains open as to precisely what accounts for the observed behavior of the Fraunhofer lines. References 5: 3 Russian, 2 Western.

UDC 551.521.31

Light-Scattering Functions in Atmospheric Surface Layer in Earth's Polar Regions

[Article by G. G. Sakunov and O. D. Barteneva, Arctic and Antarctic Scientific Research Institute]

[Abstract] Data from measurements of the scattering function for the atmospheric surface layer in Antarctica and the Central Arctic Basin are analyzed. Measurements at Mirnyy in Antarctica were made during the periods March-October 1983 and March-April 1985 (209 light scattering functions) and in the Arctic at drifting stations during the periods September-October 1978 and 1979 and February-March 1987 (400 light scattering functions). The determined functions corresponded to background observation conditions and dense hazes with a maximum in the angular variation of the scattering function in the region of the first and second rainbows at an air temperature from -15 to -30°C. The transformation of the forms of the scattering function was investigated as a function of atmospheric transparency. All the tabulated results are fitted within the framework of a classification proposed earlier (O. D. Barteneva, IZV. AN SSSR: SER. GEOFIZ., No 2, pp 1825-1865, 1960). Figures 2; references 7: 6 Russian, 1 Western.

UDC 551.466.3

Manifestation of Nonlinear Effects in Spectrum of Wind Waves

[Article by V. V. Yefimov and A. V. Babanin; Marine Hydrophysics Institute, Ukrainian Academy of Sciences]

[Abstract] Since nonlinear interactions are not the sole mechanism regulating processes of wave development and damping of waves (interaction with the atmosphere, wave collapse, turbulence and other factors must be taken into account) the discrimination of nonlinear effects is always difficult. In order to clarify this problem wind waves were measured in the Black Sea. This research revealed the existence of nonlinear components: second-approximation spectra for steep wind waves. The behavior of this spectrum is compared with theoretical findings. This comparison explains the deviation of the dispersion relation in the range of frequencies higher than the doubled frequency of the maximum which was observed earlier. It is shown that the empirical spectra are greatly blurred in the space of frequency-wave numbers relative to the dispersion curves $\omega^2 = gk$ and $\omega^2 = 2gk$, where ω is the angular frequency, k is the wave number and g is the acceleration of free falling. The angular distribution of second-approximation spectral energy is much broader than the corresponding first-approximation distributions. Figures 6; references 18: 12 Russian, 6 Western.

UDC 551.466.3

Use of Laser Scanning Method for Registry of Anisotropy of Surface Waves

[Article by V. N. Nosov, S. Yu. Pashin, D. K. Khandogin and A. B. Dubner, Acoustics Institute]

[Abstract] A method based on the scanning of the wave-covered water surface by a thin laser ray from a He-Ne laser with a power 4 mW was used for an analysis of the anisotropic properties of small-scale ripples. The experiments were carried out in a basin with a free water surface 4 x 4 m. Waves of two scales were generated at the water surface. The directed wind flow, having a speed of 5 m/s, gave rise to gravity-capillary ripples with spatial periods on the order of several centimeters. Larger-scale waves, with periods of several decimeters, were generated using a mechanical wave generator. The ray made harmonic oscillations in the vertical plane with a frequency 16 Hz. The scanning was carried out in different directions. It was found that the parameter most sensitive to the anisotropy of waves is the number of mirror reflections (glitter) registered in different azimuthal directions. Such laser scanning can be an effective method for studying the anisotropy of surface waves. Figures 5; references 11; 8 Russian, 3 Western.

UDC 551.501.7

Determination of Calibration Value in Computing Optical Characteristics of Complex Dispersive Media

[Article by M. M. Kugeyko, I. A. Malevich and S. A. Zenchenko, Belorussian State University]

[Abstract] There are many methods for computing the profiles of optical characteristics of dispersive media on the basis of optical sounding data. This is due to the great diversity of situations and the multiparameter dependence of the measured backscattering signal, making it necessary to make assumptions or use a priori information on the investigated medium. None of the known methods meet the practical requirements for dispersive media. In the processing of real signals the stability of the solution is greater the greater the volume of a priori information for distant sectors of the sounding path, but this requires use of β_k) or $T(z_0, z_k$ evaluations in the end segments of the sounding paths, which is possible using independent measurements. But if these independent measurements are impossible the calibration problem at the initial or final point cannot be solved. This article gives algorithms for obtaining the required calibration values using information contained in the lidar signals themselves. A method is given for computing the optical characteristics of media containing interfaces of different optical densities and the results of mathematical simulation of the known and proposed methods are presented. The proposed algorithms for determining the integral and local calibration values are practical since they use that information which is contained in the backscattered signals themselves. Figures 2; references 8: 6 Russian, 2 Western.

UDC 551.501.8

Doppler Tomography in Radar Meteorology

[Article by A. G. Gorelik and V. V. Sterlyadkin, Moscow Institute for Instrument Making]

[Abstract] The problem of radar Doppler tomography is formulated in in general terms and ways to solve it applicable to different models of the wind field are examined. In contrast to earlier studies (A. G. Gorelik, et al., METEOROLOGIYA I GIDROLOGIYA, No 4, pp 46-52, 1984; IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 22, No 7, pp 720-727, 1986), it was possible to solve the problem not only for a narrow class of monotonic wind fields, but in a general case for

continuous profiles, which considerably increases the practical value of this method. The article does not attempt proof of the mathematical basis for the method. Fundamental equations are derived for radar sounding of the atmosphere using Doppler systems with continuous unmodulated radiation. An analysis of direct problems made it possible to define special features and regularities in change in the form of the Doppler spectra with a change in the direction of sounding and to solve the inverse problem in determining the wind field using continuous Doppler systems. Figures 3; references 9: 6 Russian, 3 Western.

UDC 551.521

Approximations of Light Field in Medium With Strongly Anisotropic Scattering

[Article by A. Yu. Potekhin]

[Abstract] During the last decade there has been considerable progress in the study of light propagation in the depths of an absorbing turbid medium with highly anisotropic scattering. Although the theory called the "improved small-angle diffusion approximation" (ISADA) has been vigorously developed, the limits of its applicability remain unclear. in order toestimate the error arising to a number of simplifications a successive approximations method is proposed in which the zero approximation coincides with the already available rresults, whereas the next make it possible to refine, determine the error and limits of possible use for a quantitative description of the light field. in the first approximation an explicit expression in elementary functions is derived for brightness averaged in the observation plane. solutions of problems related to narrow and nonstationary light beams are aso refined. An appropriate nonstationary solution is found for the ISADA problem, as well as a new condition for its applicability in time which on long paths is more rigorous than any known earlierA simple formula is derived for the depth extinction index which is correct in a broad range of optical parameters. Figure 1; references: 15 Russian.

UDC 551.463.3

Computation of Intensity Fluctuations of Parallel Light Beam Reflected From Sea Surface

[Article by L. N. Akhmedov, R. G. Gardashov and K. S. Shifrin, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The stochastically distributed surfaces method (SDSM) is often used in computing the mean intensity of light reflected from the sea surface, but a different approach, based on the V. A. Fok reflection formulas and making use of the geometrical characteristics of the surface, is possible. Surface reflective properties are determined by the statistics of the mirror points. It is shown that in computing mean intensity both approaches are equivalent, but direct computation of fluctuation by the mirror points method gives infinite values, caused by caustics. The proper method for computing fluctuation is outlined. An explicit formula is derived for the probability density function of the radii of curvature at the mirror points for a stationary random surface. The results of numerical experiments are given which demonstrate a rate of approach of the surface brightness coefficient to its mean value corresponding to the method of stochastically distributed surfaces. Use of the formula for the distribution of curvature at sea surface mirror points is illustrated in an example. Figures 2; references: 11 Russian.

UDC 551.593

Applicability of Refraction Law for Horizontal Paths

[Article by N. Ye. Kondratyeva, M. I. Lakotko, A. S. Medovikov and G. Yu. Khacheva, Vladimir Polytechnic Institute]

[Abstract] The effectiveness and limits of applicability of the Snellius law for solving specific problems are determined by its accuracy, but the literature contains no information on experimental checking of the refraction law on horizontal paths. A study was therefore made of the possibility of applying the Snellius refraction law to the problem of excluding refraction on horizontal paths when measuring zenith distances. By accuracy in satisfying the Snellius law is meant the accuracy with which the relative elevation between points on the Earth's surface is determined. An analysis of the results on paths of different extent from 1 to 44 km revealed that the Snellius refraction law on horizontal paths is correct with an error 1-5%, but with averaging of the key parameters over a period from 1 to 3 days the error is 0.05-1%. On short paths 1-4 km the error when applying the Snellius law is about 10%. The accuracy in satisfying the refraction law increases with an increase in the length of the path and the difference in elevation between observation points. Figures 2; references: 5 Russian.

UDC 551.46.0:629.78

Inhomogeneities of Oceanic Currents and Surface Radiobrightness Temperature

[Article by V. A. Dulov, V. N. Kudryavtsev and V. S. Suyetin, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] Collapses of wind waves play an important role in forming the characteristic thermal radiation of the ocean surface in the microwave range. This article discusses the possibility of using this fact in remote detection and identification of hydrological characteristics. The representation of gradients of currents in the field of surface brightness temperature occurring due to variations in the intensity of wind wave collapse is described in detail. Models of the simplest types of currents (convergence and divergence, circular zones of upwelling and subsidence, circular currents, jet currents) are examined (currents in the ocean are usually a superposition of several of these very simple currents). It is shown that regions of vertical movements of water masses should be manifested most effectively in the brightness temperature field. The presented materials demonstrate that large-scale features in the radiobrightness fields can be detected remotely when making observations in the centimeter range. Figures 3; references 8: 7 Russian, 1 Western.

UDC 551.463

Determining Spectrum of Energy-Bearing Surface Waves From Image of Solar Glitter. Comparison With In Situ Data

[Article by A. N. Bolshakov, V. M. Burdyugov, S. A. Grodskiy, V. N. Kudryavtsev and V. G. Proshchenko, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] A method for determining the spatial energy spectrum of sea surface rises from the image of waves in the solar glitter was proposed by A. N. Bolshakov, et al. in ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 11-18, 1988. That method is based on scaling of the spectrum of brightness variations to the energy spectrum of wind waves using a linear transfer function obtained using the vector of the gradient of averaged brightness. That article, which gave the principal computation formulas,

recommendations on choice of frame fragments and the method for processing a real aerial image, is used as a basis for the described research: comparison of the wave spectra obtained from aerial photoimages and synchronous in situ measurements. The experiment was carried out in October 1987 in the western part of the Black Sea during the 17th cruise of the "Professor Kolesnikov." Shipboard hydrometeorogical observations were accompanied by measurements of the parameters of energy-bearing surface waves made using an accelerometric transducer freely drifting at a distance of about 200-300 m from the jvessel. A direct comparison of remote and contact frequency spectra gave a satisfactory quantitative correspondence of the one-dimensional characteristics. The parameters of the spatial spectrum of rises correspond qualitatively to prevailing empirical concepts on the angular structure of wind waves. Figures 4; references 7: 4 Russian, 3 Western.

UDC 551.465:629.78

Systematization of Frontal Zones of Norwegian and Greenland Seas Using Satellite Data

[Article by V. B. Rodionov and Ye. V. Belkov, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] A systematization of oceanological fronts in the Norwegian and Greenland Seas is proposed on the basis of an analysis of satellite data on sea surface temperature, supplemented by data in the literature. The principal frontal zones in the surface layer making up the North Polar Frontal Zone (consisting of the East Greenland Frontal Zone, Icelandic Coastal Frontal Zone, Icelandic-Faeroe Frontal Zone, Jan Mayen Frontal Zone, Greenland Sea Frontal Zone and the frontal zone caused by interaction between the waters of the Norwegian Current and the waters of the East Icelandic Current) and the Coastal Norwegian Frontal Zone are defined and described in detail, including information on seasonal variability of their parameters (March, April, June and December maps of the high-gradient zones are given as examples). These descriptions, maps and a table were prepared after an analysis of monthly maps of the positioning of high-gradient zones during 1980-1987 published in SATMER bulletins. The basic information used in the mapping was IR images received from NOAA satellites. Figures 3; references 23: 9 Russian, 14 Western.

UDC 528.813

Choice of Model for Computing O_2 Absorption Coefficient for Determining Atmospheric Temperature Profile From Microwave Measurements by Artificial Earth Satellites

[Article by A. A. Vlasov, Ye. N. Kadygrov and A. N. Shaposhnikov, Central Aerological Observatory, Dolgoprudnyy]

[Abstract] Different models are available for computing the O_2 absorption coefficient (Van Vleck-Weisskopf, Zhevakin- Naumov, Liebe, Rosenkranz, Lam). The results of computations using the first three models have already been compared in the literature. This article therefore gives a comparison of the results of computations made using the Lam and Rosenkranz models. These results are used in selecting an optimal computation model for practical use in processing data obtained with a satellite microwave radiometer for thermal sounding of the stratosphere (15-45 km) and making an estimate of the errors arising when using this method. The Rosenkranz model uses a first-order approximation which makes allowance only for the relationships between adjacent rotational states, which corresponds to the case when states of the oxygen molecules are weakly related in most collisions. Mathematically this is expressed in the fact that in the interaction matrix only the diagonal and quasidiagonal elements are not equal to zero. In the Lam model allowance is made for all elements of the interaction matrix when using the theory of overlapping spectral lines. In the range 53-63 GHz the mean difference between the two models is 2- 3%. It is better to use the simple Rosenkranz model in retrieving the stratospheric temperature profile since it is algorithmically more convenient and requires less computer time than the Lam model. Figures 3; references: 9: 5 Russian, 4 Western.

UDC 528.813+528.88.044

Remote Sensing of Soils in Decameter Range

[Article by A. S. Afanasyev, A. N. Belokudrenko, A. A. Garnakeryan, M. V. Kachan, M. M. Mikhalko, S. F. Pimenov, S. M. Sushchin and M. B. Entel, Physics Scientific Research Institute at Rostov State University, Rostov-na-Donu]

[Abstract] A new method is proposed for remote sensing of soils in the decameter range making possible a direct estimate of permittivity at depths of about 1 m and the position of the water table to depths of about 10 m. Soil salinization measurements are also possible. A number of experiments were carried out for clarifying the possibilities of using the decameter range for these purposes. Radar measurements were made from an AN-2 aircraft from altitudes 500-1000 m at a flight speed 180-190 km/hour. The transmitter carrier frequency was 30 MHz, pulse duration 1μs, pulse repetition rate 1 kHz. Within 24 hours after each flight measurement the soil moisture content was determined in situ. In the shortwave part of the range there is a correlation between depth of the ground water table and the magnitude of fluctuations of reflected radiation. The mean amplitude level of the reflected field at a wavelength 10 m correlates well with the moisture content in the soil layer 0-40 cm. Figures 5; references 19: 15 Russian, 4 Western.

Comparative Analysis of Statistical Characteristics of Optical and Radio Images of Soil-Vegetation Features

[Article by G. A. Andreyev, A. A. Potapov, A. V. Gorbunov, V. V. Koryakovtsev, Yu. V. Opalenov, T. V. Galkina, A. I. Kolesnikov, T. I. Orlova and Ya. L. Khlyavich, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; Voronezh State University]

[Abstract] A comparative analysis is made of criteria used in the classification of aerial photographs and radar images of vegetation covers and agricultural crops. In contrast to most articles in which the structural brightness field is used as the key criterion, the effectiveness of texture (universally present on such images) is examined as such an interpretation criterion. The authors rely heavily on and in large part proceed on the basis of an article by R. M. Haralick, et al. entitled "Textural Features for Image Classification" in IEEE TRANS., V. SMG-3, No 6, pp 610-621, 1973. The statistical processing procedures discussed in the article were used in forming clusters of texture signatures. This is illustrated, for example, in the use of 28 textural characteristics in studying 9 types of soil- vegetation covers using materials from helicopter surveys in the visible and radar ranges in winter and summer. Statistical processing procedures and the comparative effectiveness of the two mentioned ranges are discussed. Figures 5; references 15: 11 Russian, 4 Western.

Spectral Variation of Light Extinction Index in Waters of Oceanic Surface Microlayer

[Article by G. S. Karabashev and A. F. Kuleshov, Atlantic Division, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Kaliningrad]

[Abstract] The surface microlayer of the ocean is formed in calm weather, has a thickness up to 10^{-3} m and has an increased concentration of organic substances in comparison with the underlying active layer. Such substances can considerably attenuate light. Rough determinations were made of the spectra of the extinction index for water taken from the surface microlayer. The determinations were made in August-September 1988 in the Atlantic Ocean to the north of the tropical zone during the 49th cruise of the "Akademik Kurchatov." The sampler and sampling technique are briefly described. No samples were taken under calm conditions. In all cases the spectra of the extinction index for water from the microlayer differed from the extinction index for the underlying layer. The observed differences were consistent with the known distribution of biogenous matter in the surface microlayer. The spectral position of the maxima of the extinction index for water from the microlayer indicates their possible relationship to substances of protein origin. The inconstancy of the wavelengths of the maxima and the ratios of their amplitudes to the "pedestal" value indicates a variability in the composition of the colored organic compounds concentrated in the surface microlayer. Figure 1; references 3: 2 Russian, 1 Western.

Transmission and Reflection of Light by Homogeneous, Absorbing Aerosol Layer

[Article by A. S. Ginzburg, I. N. Sokolik, Institute of Atmospheric Physics, USSR Academy of Sciences]

[Abstract] Based on an analysis of the flux of solar radiation by the delta-Eddington method, simple analytic expressions are derived to calculate the transmission and reflection of solar light by a homogeneous layer of absorbing aerosol. The simple exponential approximation of transmission and reflection suggested in this work yields results which are close to calculations by the delta-Eddington method for virtually all types of non-condensation aerosols such as dust and smoke, as well as highly polluted fog. The results diverge at low sun angles. Figures 2; References 16: 6 Russian, 10 Western.

UDC 551.576:551.501.8

Influence of Raindrop Vibration on Polarization Characteristics of Radio Echo

[Article by A. G. Gorelik, V. V. Sterlyadkin, Moscow Institute of Instrument Building]

[Abstract] Experimental data are used as the basis for analysis of the influence of raindrop vibration on the capabilities of remote sensing of precipitation in the microwave band. The authors note that spectral polarization selection of the signal can be used with selection of the polarization angle to either completely eliminate the influence of vibration or distinguish the contribution made by the vibration and nonsphericity of droplets in the recorded signal. It is concluded that all raindrops experience oscillations, the influence of which on the reflected signal spectrum depends significantly on polarization of the radiation used. The shape of the raindrop-vibration spectrum can be used to determine unambiguously the microstructure of the rain. Microstructure data, plus radar reflection intensity data, can be used to determine the parameters of the Z-I ratio (radar reflectivity vs. rainfall intensity) and thus to refine methods of remote determination of rainfall intensity. Figures 3; References 15: 9 Russian, 6 Western.

UDC 551.515.2

Cylindrical Vortices with Horizontal Axis in Equatorial Atmosphere

[Article by Yu. A. Stepanyants, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] Equations are derived in a study of distributed atmospheric vortices with finite energy, vorticity, velocity field and other geophysical characteristics. Starting with a known system of equations describing the dynamics of the equatorial atmosphere within about 5° of the Equator, the authors obtains results that indicate that the presence of unstable stratification enables the existence of vortices that are stationary in terms of meridional coordinates and whose current fields diminish rapidly with distance from the core of the vortices. Vortex solutions that are constructed are anti-symmetric to the plane $z = 0$, which implies restriction to one upper or lower half-plane. The solutions can be easily extended to three or more intervals, in each of which arbitrary constants κ are assigned. Estimates are presented of the dimensions of the vortices for real

parameters that characterize the equatorial atmosphere. References 10: 8 Russian, 2 Western.

UDC 621.373

Prospects for Using $Al_2O_3{:}Ti^{3+}$ Lasers for Atmospheric Research.

[Article by G. A. Skripko, Intersector Institute of Continuing Education, Belorussian Polytechnical Institute, Minsk]

[Abstract] In discussing the prospects for the use of solid-state tunable lasers for atmospheric research, the author analyzes the most important features of a new laser medium, $Al_2O_3{:}Ti^{3+}$, and examines the characteristics of lasers that are based on such crystals. The author draws primarily from research findings at the Belorussian Polytechnical Institute to discuss the most probable directions to be taken in the development of such lasers. Based on the Soviet and Western literature, he asserts that an $Al_2O_3{:}Ti^{3+}$ laser emitting at wavelengths of 0.65-1.3 μm and supplemented by secondary-harmonic and difference-frequency generators could be used as the base for the creation of a highly efficient source of tunable, coherent radiation in the 0.32—20 μm range, suitable for measuring atmospheric aerosol, for monitoring gases, and for monitoring thermodynamic parameters of the atmosphere. When circumstances dictate expansion of the range toward the shortwave end of the spectrum—as in studies of atmospheric ozone—a third harmonic of tunable radiation could be effected, shifting the shortwave boundary to 220 nm. Lasers based on $Al_2O_3{:}Ti^{3+}$ crystals could utilize coherent, lamp or solar light or electron beams for pumping purposes. Figures 10; References 56: 38 Russian, 18 Western.

UDC 551.501+621.396.96

Resonance Scattering of Laser Radiation on Nitrogen and Nitric Oxide Molecules

[Article by O. K. Kostko, N. N. Kostko, All-Union State Head Planning-Survey and Scientific Research Institute "Soyuzgiprovodkoz" Moscow]

[Abstract] The first studies of the possibility of using resonance scattering (RS) of laser radiation to determine atmospheric composition were published in the mid-1960s. Although researchers then suggested using RS to determine metastable molecules and ions of nitrogen, nitric oxide, sodium, potassium, calcium, lithium, today's experiments involving determination of the composition of the upper atmosphere are limited to studies of the variation in metal atoms, primarily sodium. Choice of the atmospheric components to be measured

with RS is based on four conditions, which the authors here use to study the possibility of determining certain nitrogen components in the upper atmosphere: (1) the concentration of the reradiator and the cross-section of the RS must be such that the backward resonance-scattered signal is greater than the aerosol and molecular scattering; (2) the intensity of nighttime emissions must not exceed the magnitude of the backward resonance-scattered signal at the sensing wavelength; (3) the upper, excited level of transition must have a small half-life; and (4) the laser radiation at the chosen wavelength can be only weakly absorbed by other atmospheric components. The authors examine the Vegard-Kaplan electron transition and electron transitions of the first positive system in determining nitrogen molecule concentrations in the excited and base states. Among the N_2^+ ion transitions, the most perferable turned out to be the transition of the first negative system with fluctuating quantum numbers $v' = v'' = 0$. The authors found that a laser sensing equation, tables of the optical characteristics of atmospheric aerosol compiled by Zuyev and Krekov ("Opticheskiye modeli atmosfery," Leningrad, Gidrometeoizdat, 1983), and a model of a standard atmosphere can be used to calculate the minimum concentrations of nitrogen ions that are detectable—$[(N_2^+)_{lim}]$. The possibility of determining the concentration of nitric oxide for altitudes of 100-150 km is also pursued. Figure 1; References 15 (Russian).

UDC 621.373:535.317.1

Experimental Study of Correlation of Space and Specular-Reflected Waves

[Article by V. M. Sazonovich, S. M. Slobodyan, B. N. Chen, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] The influence of the spatial correlation of space and reflected waves on the variance in optical image shifts is studied experimentally in a simulated thermal convective turbulence. With reflection off a flat mirror, correlation of space and reflected waves quadruples image jitter variance; with reflection off an angular surface, it leads to full compensation for random optical image shifts. Decorrelation of the waves leads to a reduction of image jitter variance (reflection off a flat mirror) and to an increase in variance (reflection off an angular surface) to a magnitude that is the sum of image jitter variances on the source-reflector path and the reflector-receiver path, with the type of specular reflector of little importance. The effect of separation of the axes of space-wave and reflected-wave beams on their correlation to each other was studied experimentally in a randomly inhomogeneous medium. Self-compensation in radiation reflected from a right-angle prism and the fluctuation amplification in reflection from a flat mirror

are found to depend on beam axis separation. Figures 3; References 11: 10 Russian, 1 Western.

UDC 535.416:535.31

Numerical Solution of Nonlinear Optics Equation by Fourier-Bessel Transforms

[Article by V. L. Derbov. Yu. N. Ponomarev, S. K. Potapova, Saratov State University, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] Successful use of an algorithm for a fast Fourier-Bessel transform by Vysloukh and Matveyeva (IZV. VUZOV. RADIOFIZIKA, 1985, Vol 28, No 1, pp 101-106) prompted the authors to create a calculus similar to that advanced by Igumnov et al. (Preprint, IN-T. TEORETICH. I PRIKL. MEKHANIKI SO AN SSSR, No 25-83, 1983) with an improved algorithm with radially symmetrical nonlinear wave equations describing the nonlinear propagation of light. The results obtained indicate that cubic nonlinearity has a significant influence on the process of propagation of a Gaussian beam of radiation in an axially symmetrical heterogeneous medium. The results also demonstrate the possibility of effective utilization of the algorithm developed to model the propagation of light beams in nonlinear heterogeneous media, particularly in problems of laser probing of the atmosphere and atmospheric optics. Figures 5; References 7: 5 Russian, 2 Western.

UDC 535.212

Acoustic Measurement of Energy Distribution in Laser Beam Cross Section

[Article by V. V. Vorobyev, M. Ye. Grachova, A. S. Gurvich, V. S. Myakinin, Institute of Atmospheric Physics, USSR Academy of Sciences, Moscow]

[Abstract] Results are presented from a model experiment illustrating the possibility of determining the distribution of energy in light beams by acoustic measurement. The researchers studied the change over time in the pressure in a medium exposed to short laser pulses with a duration τ that was less than the characteristic time of pressure change in an acoustic pulse $\tau_{ac} = l/u$, where l represents the minimal spatial dimensions of light intensity inhomogeneities and u is the speed of sound, with relaxation time τ_{rel} of the light energy absorbed into thermal smaller than τ_{ac}. Distributions measured by the acoustic method are compared with distributions measured photometrically, and there is good agreement of the energy distribution profiles produced by the two methods. The method does not require

introduction of measuring elements in the propagation channel, and it permits monitoring of the parameters of radiation in real time. Figures 4; References 3 (Russian).

UDC 551.510.42

Inverse Problem Method in Polarization Soundings of Dispersed Media

[Article by I. E. Naats, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] This work continues development of the theory of polarization soundings of dispersed media, particularly the extension of the operator approach not only to the joint inversion of the elements of a Muller matrix, but also to their determination in an experiment with sparse data. The author elaborates a method of interpretation that enables the development of practical procedures for studying actual aerosol systems of natural or anthropogenic origin with surface and airborne nephelometers and bistatic lidars. The method is applicable to optical monitoring of aerosol atmospheric pollution. The information capabilities of the approach are illustrated by solving a complex problem of atmospheric optics involving separation of molecular and aerosol scattering matrices on the basis of polarization measurements. References 11: 9 Russian, 2 Western.

UDC 551.591.593

Optical Manifestations of Noncondensation Aerosol Clouds

[Article by Ye. Zuyev, V. D. Belan, V. V. Veretennikov, G. D. Zadde, M. V. Panchenko, R. F. Rakhimov, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] Noncondensation clouds are localized regions that appear in a clear, dry atmosphere above altitudes of 1 km and have aerosol concentrations 4-60 times greater than that of the surrounding air. They have a relatively high concentration of dust particles 1-4 μm in diameter. Although noncondensation clouds are relatively rare, they are of interest for two reasons. First, regions whose optical characteristics differ from those of the surrounding air can have a great effect on the operation of optical instruments and on the interpretation of the data of optical observations. Second, the nature of the function of particle-size distribution makes the optical characteristics of noncondensation clouds quite different from those used to model atmospheric haze. The authors estimated the optical properties of aerosol noncondensation clouds by examining the results of calculations performed on the assumption of particle sphericity and

isotropicity; they used data of microstructure measurements made with a photoelectric counter in the radius range of 0.2-5 μm. They use experimental data on the microstructure and chemical composition of these clouds to compute spectral extinction coefficients constants and lidar ratio. The data indicate that these clouds can be easily detected and identified by multifrequency laser soundings (the most effective being in the near IR area of the spectrum. Figures 4; References 7 (Russian).

UDC 551.521

Optimal Experiment Planning in Upper Atmosphere Sounding Experiments in 15 m Band of CO_2 Temperature, Kinetics, Composition

[Article by A. I. Demyanikov]

[Abstract] A method is presented for remote determination of temperature distribution $T(z)$ in the region in which the local thermodynamic equilibrium is disrupted. The method does not require a priori knowledge of the vertical profile of the probability of survival of quanta in scattering, $\Lambda(z)$, or of CO_2 ratio, q_{CO_2}, and is based on strict solution of the problem of optimal selection of three spectral channels to provide information on $\Lambda(z)$ and q_{CO_2}, as well as on $T(z)$, when experimental data are processed. The author presents a two-channel version that is said to be superior to an earlier version he proposed for solving the problem of joint retrieval of $T(z)$ and $\Lambda(z)$ when q_{CO_2} is known. He demonstrates that today's cooled radiation detectors can be used to determine the temperature of the atmosphere at altitudes of up to 100 km, with an accuracy of 1 K. Figures 2; References 13: 8 Russian, 5 Western.

UDC 543.422.4.551.510.522

Laser Device for Measuring Extinction Coefficients at = 10.6 m

[Article by Yu. A, Ivankin, A. P. Cherepanov, R. Sh. Tsyvk, I. Ya. Shapiro, Yr. F. Yatskeyev, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk: "Optika" Special Scientific Instrument Design Bureau, Siberian Division USSR Academy of Sciences, Tomsk]

[Abstract] An attempt is made to summarize the experience accumulated by the authors in the development and testing of a laser device for measuring the extinction coefficient of atmospheric radiation at $\lambda = 10.6$ μm. The authors demonstrated the necessity of complete capture of the radiation flux to decrease the influence on measurement accuracy of flux axis wandering, energy redistribution over the cross section, and flux expansion in a turbulent atmosphere. The results obtained indicate the

device, operating over a path of 500 m, can measure the attenuation factor at 10.6 µm within the 0.06-4.00 km^{-1} band with a relative rms error of not over 6%. Figures 2; References 10: 9 Russian, 1 Western.

UDC 551.521:551.576

Numerical Study of Aerosol Extinction of Radiation at λ = 10.6 µm with Stratus Clouds

[Article by V. V. Antonovich, G. O. Zadde, A. V. Podanev, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] A study is made of the dynamics of the aerosol extinction factor of CO_2-laser radiation at λ = 10.6 µm in a developing cloud layer. The studies were based on a simple hydrodynamic model of the evolution of cloud fields and temperature fields in a moving cyclone, supplemented by assumptions concerning the size distribution of droplets. Variables in the model consisted of turbulence coefficient (k), maximum convective velocity (ψ_m), time constant in hours (t_k), and convective cloud-layer height (H). Calculations were performed for two sets of initial parameters. The first set, borrowed from Bykova and colleagues ("Oblaka i klimat" [Clouds and Climate], Leningrad, Gidrometeoizdat, 1986) modeled the development of dense cloud cover with H = 11 km, k = 5 m^2/s, ψ_m = 0.025 m/s, f_1 = 0.7, r_2 = 0.9, and t_k = 24 hours. The second set consisted of low, mean statistical St-Sc clouds with H = 1.9 km, k = 0.9 m^2/s, ψ_m = 0.01 m/s, f_1 = 0.75, r_2 = 0.9. Figures 3; References 7 (Russian).

UDC 621.373

Laser Emission on Al_2O_3:Ti^{3+} Crystals Excited by Electron Beams

[Article by G. A. Skripko, S. G. Bartoshevich, V. V. Zuyev, A. N. Maltzev, Intersector Institute of Continuing Education, Belorussian Polytechnical Institute, Minsk; Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] Previous studies of the generating characteristics of tunable Al_2O_3:Ti^{3+} lasers have centered on optical pumping. The authors here present results from studies of the possibility of creating a tunable Al_2O_3:Ti^{3+} laser pumped by beams of fast electrons. Studies were performed on an installation using a 109 keV electron gun with a beam current density of about 10 A/cm^2, pulse length 50 ns, pulse repetition frequency up to 5 Hz. A second installation was used to study the possibility of achieving generation in an external resonator, using a 600 keV electron gun with current density 150-500 A/cm^2, pulse length at half-height level 25 ns. The

possibility is demonstrated of producing stimulated radiation in the red and near-IR region with electron excitation. Total energy efficiency is 4-8%. Figures 2; References 6: 5 Russian, 1 Western.

UDC 551.551.5/.8:551.511

Structures of Turbulent Heat Flows in Lower Troposphere

[Article by N. Z. Pinus, professor, Central Aerological Observatory]

[Abstract] This article is essentially a continuation of earlier studies by the author (IZV. AN SSSR; FAO, Nos 1, 8, 1988; METEOROLOGIYA I GIDROLOGIYA, Nos 5, 11, 1989). It represents a more detailed study of heat exchange in turbulent shear currents in the lower troposphere and detection of links between the turbulent flows of heat and turbulent flows of momentum, indirectly reflecting coherent structures in turbulent currents. The data for this research included synchronous measurements of w', v' and T' fluctuations measured from an aircraft at altitudes from 300 to 3000 m in April 1986 and May 1987 near Dnepropetrovsk. The cospectra and spectra of the coherence coefficients of w' and v', w' and T', v' and T' were obtained for the range of wave numbers 1.5 x 10^{-4}-3.3 x 10^{-4} m^{-1}. A comparative analysis of the cospectral and coherent structures of turbulent heat flows and the cospectral and coherent structures of turbulent flows of horizontal momentum indicated a high correlation of these flows. The role of stable and unstable thermal stratification in the coherent structure of turbulent shear currents is clarified. Figures 5; references 7: 6 Russian, 1 Western.

UDC 551.551.2

Turbulence Characteristics in Atmospheric Surface Layer

[Article by G. L. Lazriyev, candidate of physical and mathematical sciences, and A. A. Ioseliani, Transcaucasian Regional Hydrometeorological Scientific Research Institute]

[Abstract] Most research on atmospheric processes carried out at the present time is based on the Monin-Obukhov similarity theory proposed in 1953-1954. The necessary universal functions have usually been determined by measuring mean wind speed and potential temperature at several levels. Methods for measuring these parameters have constantly improved but different authors have failed to arrive at the same universal functions. An effort was therefore made to find universal functions best ensuring correspondence between theory

and observational data on the basis of a comparison of the computed and measured turbulent flows of heat and momentum. The study was made using data from two micrometeorological experiments carried out in Australia in 1967 and 1970. Both experiments included wind speed measurements at several altitudes, the temperature difference between these two altitudes and the turbulent heat flow. It is shown that use of the Businger-Dyer universal functions and generalized KEYPS formulas gives the best agreement between theoretical and computed data. References 9: 6 Russian, 3 Western.

Determining Heat Inflows Due to Phase Transitions in Atmosphere Over Ocean

[Article by B. N. Yegorov, candidate of geographical sciences, and S. P. Malevskiy-Malevich, candidate of physical and mathematical sciences, Main Geophysical Observatory]

[Abstract] A radiation model based on measured temperature and humidity profiles and data from actinometric observations was used in an attempt to estimate the liquid-water content of clouds in a test range in the Newfoundland Energy-Active Zone during the period 3-22 March 1988. These data were used in determining the contribution of advection of liquid-droplet moisture to the formation of heat inflows due to phase transitions in an atmospheric column over the ocean. The results indicate that the availability of precipitation data provides a basis for their use in estimating phase influxes into the atmosphere at least up to the level of synoptic time scales. The errors in determining the phase influx of heat in the atmosphere from the quantity of precipitation in local in situ experiments are estimated. These errors are virtually completely governed by the accuracy in determining precipitation. The methods now used are extremely approximate and the tabulated precipitation data contain errors considerably exceeding the contribution of advection of the liquid-droplet phase. Accuracy can be improved only by using modern radars and microwave radiometers for obtaining data on the dynamics of cloud properties. Reference: 1 Russian.

Light Scattering Index Profile Determined From Polarization Parameters of Backscattered Radiation in Pulsed Sensing of Ocean

[Article by A. P. Vasilkov, T. V. Kondranin and Ye. V. Myasnikov Oceanology Institute, USSR Academy of Sciences; Microinstruments Scientific Research Institute]

[Abstract] The influence of stratification of the scattering index on the dependence of the degree of polarization of backscattered pulsed radiation on time is analyzed and a method is proposed for using this dependence to determine the vertical distribution of the light scattering index. In the measurement scheme a laser with a narrow directional diagram emits a short light pulse with plane polarization. The backscattered signal is registered by a detector situated near the light source and oriented parallel to the optical axis of the source. The time dependence of strength of the backscattered signal is registered with orientation of the analyzer parallel and perpendicular to the polarization plane of the sensing light beam. The problem is solved using the vector equation for radiation transfer in a small-angle approximation. The performance of the method was checked by numerical simulation. In contrast to methods proposed earlier, this approach makes no use of a priori information on the vertical distribution of the absorption and backscattering indices; in addition, there is no need for absolute measurements. The results given are also correct for ocean sensing by a light beam with circular polarization. Figures 2; references: 9 Russian.

Signal-to-Noise Ratio in Observation of Object in Medium With Fluctuating Optical Parameters

[Article by I. L. Katsev and A. S. Prikhach, Physics Institute, Belorussian Academy of Sciences]

[Abstract] In the theory of vision it is usually assumed that most of the photodetector noise is caused by shot

fluctuations which are dependent on the mean signal level and internal noise of the system, determining its threshold contrast. Under real conditions, however, the image often contains a noise component caused by random modulation of the signal due to fluctuations of parameters of the transmitting medium. In some cases its contribution is comparable to and even exceeds the contribution of shot noise. Such a situation may arise when making observations through a cloud with a stochastic structure or through the wave-covered sea surface. A characteristic feature of this noise is a real possibility of its correlation for intercomparable image elements since the spatial correlation scale for the image noise corresponds to the correlation scale of macroinhomogeneities in clouds or sea surface waves. A study was therefore made of the influence of such spatial correlation of noise on the signal-to-noise ratio in the image. Formulas are derived which make it possible to understand and qualitatively explain some characteristics of vision in media with fluctuating optical parameters. They can serve as a practical basis for computing the signal-to-noise ratio and solving problems related to the range of detection of objects with allowance for the noise and image correlation properties. References: 10 Russian.

Conditions for Appearance of Anomalous Features of Aerosol Extinction of Ultraviolet Radiation During High Atmospheric Transparency

[Article by V. L. Krauklis, G. A. Nikolskiy, M. M. Safronova and E. O. Shults, Leningrad State University]

[Abstract] A mass of spectral, actinometric and meteorological data collected during periods of increased solar activity (1981-1988) was analyzed for the purpose of detecting the mechanisms of the influence of solar emissions on the troposphere. For the first time data revealed that water vapor has the property of undergoing transition from a free state into a bound state (association in clusters) and back under the influence of microwave radiation, and as auxiliary factors, ultraviolet and corpuscular radiations. The transition of water vapor molecules into a bound state results in a decrease in spectral optical depth in the visible and near-IR spectral regions, appearance and deepening of cluster absorption bands in the regions 330-340, 365 and 380-390 nm. The optical depth of the atmosphere due to cluster absorption can attain 1.0 in the range 330-340 nm. The effects of anomalous transparency and anomalous selectivity are associated with the same processes of clusterization of water vapor molecules. Figures 4; references 14: 11 Russian, 3 Western.

Spectral Extinction and Asymmetry Coefficients for Light Scattering by Aerosol With Mean Weighted Particle-Size Distribution

[Article by N. I. Gorshkova, O. M. Korostina and V. A. Smerkalov, Physics Scientific Research Institute, Leningrad State University; Applied Geophysics Institute imeni Akademik Ye. K. Fedorov]

[Abstract] A fundamental but very simple two-parameter function, the mean weighted particle-size distribution, can be used in research on the optical characteristics of aerosol. With an effective refractive index of particles m = 1.53-0.007i the spectral variation of the extinction coefficients and the form of the light scattering function for particles of such an aerosol correspond to the really observed optical characteristics of continental aerosol. The semiempirical dependencies of optical characteristics of aerosol on its microstructure derived in this study can be used in interpreting the results of statistical research on the optical properties of atmospheric aerosol under different climatic conditions. The close coincidence of the determined values of asymmetry Γ and the Angstrom index ω with the mean values of these characteristics evidently confirms that in developing statistically sound atmospheric optical models the proposed fundamental distribution can be used as the mean weighted particle-size distribution for continental aerosol. Figure 1; references 9: 8 Russian, 1 Western.

Optimal Transparency Measurements in Visible Range on Tangential Paths

[Article by A. A. Buznikov and A. I. Demyanikov, Leningrad Electrical Engineering Institute imeni V. I. Ulyanov (Lenin)]

[Abstract] The problem of optimizing transmission measurements on tangential paths of direct solar radiation in the visible spectral range is examined. It is shown that by an effective positioning of the measuring channels without an increase in the volume of measurements it is possible to achieve an increase in the accuracy in retrieving optically active components in the stratosphere. The possibilities of this approach are demonstrated in the example of NO_2 retrieval. The use of the proposed channels instead of the SAGE-II channels gives a gain in the retrieval accuracy by a factor of approximately 3. There is also an improvement, although not so significantly, in retrieving all the remaining atmospheric

components attenuating radiation. When using the proposed parametrization of aerosol extinction for determining NO_2 it is best to make measurements not in the long-wave part of the range where aerosol extinction dominates, but in the short-wave region. Additional measurements in the NO_2 band in order to increase the accuracy in its retrieval should be made at the additional maxima of the dependence of the volumetric absorption coefficient on wavelength, not using the SAGE-II "maximum-minimum" pairs 0.448 and 0.453 μ. Figures 3; references 10: 7 Russian, 3 Western.

Absorption of Laser Radiation Power by Aerosol Particles in Atmosphere of Resonantly Absorbing Gas

[Article by Yu. N. Ponomarev, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] During propagation of laser radiation through an aerosol-gas atmosphere the energy dissipated by an individual aerosol particle can be dependent on the nature of absorption of radiation by the gas medium. When relaxation of vibrational energy during intercollision of molecules is slow, a considerable part of the energy of vibrational excitation can be transferred to the aerosol component due to heterogeneous relaxation of the excited molecules on the surface of aerosol particles. These phenomena were investigated with the transmission of the radiation of a pulsed CO_2 laser through the atmospheric surface layer. Estimates were made of the ratio of the energy transferred from molecules to the energy absorbed by the aerosol particle proper. The results of the estimates and preliminary experiments are given. These indicate the possibility of existence of such exchange under real atmospheric conditions. Although the results are indirect confirmation of the significance of energy exchange between excited molecules and aerosol particles, quantitative estimates require direct experiments for observing changes in the optical parameters of finely disperse aerosol in the atmosphere absorbing and not absorbing gas emission. Figure 1; references; 5 Russian.

Summation of Frequencies in Focused Beams

[Article by S. D. Tvorogov and V. O. Troitskiy, Optika Special Design Bureau for Scientific Instrument Making, Tomsk]

[Abstract] A new approach is proposed for solution of the problems arising in nonlinear interaction of focused beams in anisotropic crystals. In the first stage a rather good approximation was found for the Green's tensor of an anisotropic medium and a solution of the wave equation was found for the vector of a monochromatic field in a homogeneous uniaxial crystal. Then the "stipulated field" approximation (which is fully described) was used in deriving an expression for the wave at the total frequency with arbitrary boundary conditions. These results are applied in solving the problem of three-frequency interaction of focused beams in a KDP crystal. As a simplification the case of Gaussian beams is considered. The solution for the transformed wave obtained in the stipulated field approximation is generalized to the case of generation of the second harmonic in an essentially nonlinear generation mode. The computations made using the stipulated field approximation are in general good agreement with experimental data. Figures 2; references: 7 Russian.

influence of Atmospheric Turbulence on Refractive Image Shift of Optical Source

[Article by V. A. Banakh, A. R. Larichev, V. M. Sazanovich, R. Sh. Tsvyk and B. N. Chen, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The propagation of optical waves in an inhomogeneous medium is accompanied by a refractive deflection of an optical beam from its initial direction. Earlier work indicated that the degree of refractive image displacement of an optical beam during propagation in a regularly inhomogeneous medium is dependent on diffraction conditions at the emitting aperture of the optical source and the spatial coherence of its radiation. However, the real atmosphere is usually a randomly inhomogeneous medium. Atmospheric turbulence is manifested as a negative factor worsening the effectiveness of use of the mentioned dependence for determining the angle of atmospheric refraction from the displacement of the image of an optical source. This article gives the results of theoretical and experimental research on the influence of atmospheric turbulence on the refractive displacement of an optical image under various conditions. The experimental data confirm the dependence of refractive displacement of the optical image on diffraction conditions at the emitting aperture discovered earlier (V. A. Banakh, et al., OPTIKA I SPEKTROSKOPIYA, Vol 62, No 5, pp 1136-1140, 1987; OPTIKA ATMOSFERY, Vol 1, No 2, pp 106-107, 1988). Figures 3; references: 7 Russian.

UDC 535.3

Wave Front Retrieval on Basis of Orthogonal Functions From Results of Measurements With Hartmann Transducer

[Article by D. A. Bezuglov and A. A. Vernigora]

[Abstract] An algorithm has already been proposed for wave front retrieval using measurements of partial derivatives at aperture points. In processing measurement results from m x n subapertures this requires solution of a system of (m+1) (n+1) linear algebraic equations and recursion procedures cannot be used. With large m and n this requires increased expenditures of computer time and the use of this algorithm at a real time scale is limited, whereas an m and n decrease results in an increase in the error in phase front approximation. An effort has been made to eliminate these difficulties. Although in adaptive optics interest has been shown in the use of flexible mirrors with response functions close to Zernike orthogonal polynomials as phase front correctors, a procedure was required for computing the controlling signals for the mirrors with minimal expenditures of computer time. A suitable numerical algorithm is proposed for retrieving the phase front in the form of an expansion in a system of orthogonal functions using the results of measurements of partial derivatives of the phase front at aperture points of a Hartmann transducer. An example of application of the algorithm (economical in use of computer time) is given when using Zernike polynomials represented in a Cartesian coordinate system as an orthogonal base. References 6: 4 Russian, 2 Western.

UDC 551.531

Composite Signal Model for Interpreting Results of Photometric Measurements of Cloud Fields

[Article by V. K. Oshlakov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Estimates of the probability of presence of clouds on the line of sight can be made using the results of daytime photometric measurements. This is illustrated by the results of zenith brightness observations made in May 1987. The spatial inhomogeneity of the cloud field is manifested in the time trends of the observed brightness values in the sighting direction. The proper correction for the trend requires additional information on observation conditions, especially on the altitude of the lower cloud boundary, intensity and rate of layer movement, coordinates of the angular position of the sun and probability of presence of clouds on the line of sight. Information on some of these factors can be obtained from the results of photometric observations. The probability of presence of clouds at the zenith, for example, can be determined if in addition to the observed brightness values the brightness of the cloudless zenith is also known. The influence of variability of the vertical and horizontal dimensions of cloud field elements must be determined separately. Figures 2; references: 8 Russian.

UDC 621.306.61.061

Retrieval of Images Distorted by Symmetric Blur

[Article by S. G. Balashov, A. A. Pakhomov, A. D. Ryakhin and Yu. A. Sadykov, Astrofizika Scientific Production Association]

[Abstract] A distorted (blurred) image, caused by atmospheric dispersion, is a common problem in such fields as astronomy and aerial photography. Situations are common when information on blur structure is limited by its symmetry condition. A theoretical study was therefore made of the possibility of retrieving a two-dimensional image distorted by a symmetric blur relative to the components of its Fourier transform. The use of certain properties of the blur function makes it possible to discriminate undistorted information on the ratio of image Fourier spectrum components and the blur compensation problem can be reformulated as the problem of image retrieval from this ratio. The problem can be solved using an iterational algorithm of the type used by D. Youba, et al. in IEEE TRANS. MED., Vol 1, No 2, pp 81-94, 1982. The special algorithms written on this basis were experimentally checked by mathematical simulation. This revealed that a relative rms retrieval error not worse than 1% is attained after 50-100 iterations. Figure 1; references 6: 2 Russian, 4 Western.

UDC 551.501:551.506:551.51

Stochastic Models for Classifying Satellite Information on Atmosphere

[Article by G. S. Dvoryaninov and M. V. Shokurov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] On the basis of satellite information on outgoing long- wave radiation, cloud cover and meridional movements of the Intertropical Convergence Zone in the Atlantic Ocean stochastic models of these processes were constructed for the purpose of their use in automatic classification (linguistic analysis) of observational data. Generalized ARMA (autoregression moving averages)

models were constructed which additionally take into account periodic determinate trends and modulation of the random part of the determinate component. It is shown that the models satisfy the necessary criteria and reliably describe all the principal statistical characteristics of the investigated processes. The models can be used in a quite full analysis of investigated processes and they are stochastic prognostic models, making it possible to predict a process and the variability of its statistical properties on the basis of preceding information. Despite the need for using and checking a series of criteria, the expenditure of computer time is modest. Figures 6; references 9: 8 Russian, 1 Western.

UDC 528.813

Influence of Variations of Microphysical Characteristics of Stratospheric Aerosol on Accuracy in Polarization UV Method for Determining Vertical Profiles of Ozone and Aerosol Content

[Article by M. S. Biryulina and Yu. M. Timofeyev, Leningrad State University]

[Abstract] The influence of variations of the microphysical characteristics of stratospheric aerosol on the accuracy in determining the vertical profiles of ozone content and the total concentration of aerosol particles is investigated on the basis of measurements of outgoing UV radiation, with allowance for polarization, using a linear algorithm for solving the inverse problem with conditions more realistic than examined in earlier studies. It was found that variations in the microphysical characteristics of stratospheric aerosol, like variations in its total concentration, corresponding to their global variability, exert an appreciable influence only on the parallel component of outgoing UV radiation in the considered spectral range 260.6-302.1 nm. The corresponding relative variations are maximal in the transparent measurement channels and increase with an increase in atmospheric turbidity. Variations of m (complex refractive index) and f(r) (particle-size distribution function) lead to radiation variations constituting only 10-25% of the useful signal, that is, radiation variations caused by typical variations of O_3 content and N(z) (vertical profile of total concentration of aerosol particles). The accuracy of the polarization UV method for determining the O_3 content decreases insignificantly when f(r) and m variations are taken into account. Variations in the microphysical characteristics of stratospheric aerosol somewhat reduce the accuracy in determining N(z) in the altitude range 10-30 km, but in this case the polarization UV method makes it possible to obtain valuable information on the total concentration of stratospheric aerosol particles in a broad range of altitudes 23-60 km. Figure 1; references 16: 11 Russian, 5 Western.

UDC 551.571:629.78

Comparison of Data on Atmospheric Moisture Content Over Tropical Atlantic From Satellite and Shipboard Microwave Radiometric Measurements

[Article by A. B. Akvilonova, T. V. Aleksandrova, I. T. Bubukin and M. S. Krylova, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; Radio Physics Institute Scientific Research Institute, Gorkiy]

[Abstract] A comparison of the total atmospheric moisture content over the ocean in parts of the Tropical Atlantic obtained using microwave-radiometric measurements from the "Cosmos-102" satellite and from the "Akademik Kurchatov" research ship, employing different measurement methods and instruments, revealed good agreement. The principal parameters of the radiometers, measuring and processing methods are described. The total atmospheric moisture content obtained by these two independent types of measurements differ from one another by not more than 0.5 g/cm^2 and thus the data from the two experiments coincide within the limits of measurement error. It is possible to use single-channel satellite measurements at 1.35 cm and the method for the continuous calibration of data with the indicated accuracy in the absence of a well-developed cloud cover. References: 9 Russian.

UDC 528.7:528.8

Image Classification Based on Textural Criteria

[Article by G. A. Andreyev, A. A. Potapov, T. V. Galkina, A. I. Kolesnikov, T. I. Orlova and Ya. L. Khlyavich, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow; Voronezh State University]

[Abstract] Since many sectors of the Earth's surface are without definite landmarks their images are stochastic textures. The principal merit of textural criteria is the speed with which they are computed and the high probability of correct identification of the classified textures due to allowance for interelement correlations. The image classification problem was investigated using photoimages of texture of the sea, a hardwood forest and a sandy surface. The data were prepared in the form of digital two-dimensional fields with six levels of image quantization. The quantization levels were obtained by uniform division of the brightness scale into six steps. A total of 28 textural criteria were computer processed. The classification procedures are described in detail. Five of these 28 criteria were selected which made it

possible to obtain a probability of correct identification: 78% for the sea, 85% for the forest and 99% for sand. The most informative criteria were f_4, f_7, f_8, f_{17} and f_{25}. The choice of only five (the most informative) of the 28 criteria made it possible to solve the problem of reduction of classification time with an insignificant decrease in the probability of correct texture recognition. A method based on comparison of a posterior probabilities is most suitable for discriminating textural criteria having high separation qualities. Figures 3; references 8: 5 Russian, 3 Western.

UDC 528.7.08:553.3

Digital Processing of Multiband Imagery for Optical Regionalization of Ore Fields

[Article by V. Yu. Losev, V. V. Novikov, Kh. G. Tadzhiddinov and A. K. Basanin, Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, USSR Academy of Sciences, Moscow; State Astronomical Institute imeni P. K. Shternberg, Moscow; USSR Technical Documentation Scientific Research Center, Moscow]

[Abstract] Spectrophotometric studies were made of finely disperse samples of magmatic rocks in the spectral range 400-750 nm. It is shown that on the basis of albedo values it is possible to discriminate rocks of different petrographic groups (basic, ultrabasic and alkaline). Crystal field theory is used in interpreting the interrelationship of optical and chemical parameters. The influence of dispersivity of samples on the albedo-color dependence is analyzed. The possibility of using multiband images for geological-geochemical regionalization of ore-bearing areas is demonstrated and modern digital methods for processing images are evaluated. This is illustrated by lithogeochemical mapping of a specific geological formation on the basis of optical indicators, involving an experimental survey and the taking of rock samples for measuring optical parameters. The proposed method can be used in routine evaluation of the geological-geochemical structure of deposits of any type of mineral with surface shows. Use of a computer affords a possibility for obtaining reliable data, their speedy processing and organization of a data bank of spectral characteristics of geological formations. Figures 3; references 10: 9 Russian, 1 Western.

UDC 528.711.1:77

Colorimetry as Employed in Photo Production With Multiband Synthesis Projectors

[Article by V. A. Grechanovskiy, Planning-Design Bureau, Aerogeopribor Production Association, Vinnitsa]

[Abstract] For effective recognition of features in inaccessible and poorly studied regions the multiband synthesis process must be carried out in colors as close as possible to natural. However, at the present time the visual-instrumental identification of natural features on the basis of their color has been studied inadequately and virtually no equipment has been developed for this purpose. The SPM-1 synthesizing projector (described in detail by Yu. V. Kiyenko, et al. in GEODEZIYA I KARTOGRAFIYA, No 8, pp 45-51, 1987) can be used for this purpose (this is similar to the MSP-4 instrument produced by Carl Zeiss Jena). A block diagram of the photoelectric colorimeter used in conjunction with the SPM-1 is given and their joint operation is described. In synthesis with the SPM three channels with different light filters are used. The colors of the natural features which were reproduced on the screen were obtained in flight tests with the "Tsvet-2" airborne three-color photoelectric colorimeter. Use of the described outfit makes it possible to avoid subjectivity in evaluating synthesis variants. Accordingly, in the process of synthesis of multiband images for the purpose of obtaining the most informative image with the required color characteristics with an objective evaluation of the quality of the registered image it is necessary that the synthesis process be accompanied by colorimetric measurements, and in case of necessity, be accompanied by a multiband aerial survey with a remote spectrocolorimeter. Figures 2; references: 5 Russian.

UDC 528.83

Evaluating Limiting Requirements of Users and Physical Limitations in Problems of Research on Earth's Natural Resources

[Article by G. R. Uspenskiy, A. A. Astashkin and A. I. Bobrovnichiy]

[Abstract] The limiting characteristics of passive sensors for remote sensing of the Earth are evaluated. The study

is oriented on potential requirements of users. The limiting physical restrictions in the procedure of synthesis of maximally attainable parameters are formulated on the basis of the uncertainty principle. A table lists the user requirements discussed (compilation of cartographic base; multispectral and structurometric classification; monitoring of atmospheric composition; determination of surface temperature; determination of height of waves and ocean surface topography; determination of wind speed; determination of subsurface characteristics). By the year 2000 the requirements of users will be approximately an order of magnitude greater than existing capabilities. A forecast gives the following limiting parameters: 1) 0.5-1 m for structurometric channels of survey systems and 3-5 m for multiband surveys; 2) 500-1000 spectral channels for survey systems of the videospectrometer type; spectral resolution at the level $\Delta\lambda/\lambda$ less than or equal to 10^{-4} for passive spectrometers of the sounding type and 10^{-6} for active laser systems; 3) study of calamitous natural phenomena requires continuous observations with a period of data revision up to several minutes; 4) energy resolution 0.01% for making observations in a broad range of brightness changes without change in the operating mode of the survey systems. The physical limit for information characteristics of survey systems is determined by atmospheric fluctuations for spatial resolution (at the level 0.5-1 m), by natural emission (absorption) line width of natural formations for spectral resolution and by the number of averaged basic elements for energy resolution. These and other user requirements are summarized in a second table. Figure 1; references 9: 7 Russian, 2 Western.

UDC 528.711.1.029.67

Analysis of Requirements on Space Information Parameters

[Article by Yu. P. Kiyenko and G. A. Savin, Priroda State Scientific Research and Production Center]

[Abstract] The results of expert evaluations of requirements on space information parameters are given. The requirements on space information are made more precise on the basis of the results of analysis of information-bearing signatures for the radiation field of natural formations and physical limitations on the technical realization of promising survey systems for research on the Earth's natural resources. The necessary number of survey zones for remote sensing instruments and their
arrangement in the radiation spectrum are evaluated. The preliminary requirements for future surveys for studying natural resources are formulated as follows. The spatial resolution in the visible and near-IR zones should be up to 3-5 m with a scanning band 100-200 km (it is infeasible to achieve a higher resolution, such as 0.5-1 m, in the next 10-15 years). There must be a possibility for regulating the spectral composition of the registered radiation in 3-4 survey channels in the wavelength range 0.4-1μm. High-resolution information in the visible range must be supplemented by surveys in 2-3 IR channels and in 2-3 channels in the radio range of the electromagnetic spectrum. Multiband information must be interpreted with allowance for the brightness, polarization, angular and structural characteristics of the radiation field of natural formations. Figures 4; references 7: 6 Russian, 1 Western.

UDC 551.510.42:551.521.3

Light Depolarization Accompanying Scattering by Smoke Aerosols

[Article by V. N. Sidorov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] In an earlier article (IZV. AN SSSR: FAO, Vol 24, No 3, pp 262-273, 1988) the author gave the results of measurements of four components of the matrix of light scattering by smoke aerosols registered using a polarization nephelometer for five fixed scattering angles. In most cases such information is adequate for describing light scattering by particles of a spherical shape. However, data from direct microstructural measurements and data from electrooptical research in many cases indicate a considerable anisometry (asphericity) of particles of smoke aerosol. This circumstance therefore dictated a more rigorous validation of the method used in the inversion of optical data based on application of the Mie theory. An estimate of the degree of asphericity of the particles of investigated aerosol is desirable in each specific case. Accordingly, the components of the matrix for light scattering by smoke aerosols of different type were measured. Spectral measurements indicated an intensification of the depolarizing properties of aspherical particles with an increase in their size. The estimates of the degree of asphericity of smoke particles under conditions of their chaotic orientation are consistent with the results given by V. N. Kapustin, et al. in IZV. AN SSSR: FAO, Vol 24, No 3, pp 280-289, 1988. Figure 1; references 13: 11 Russian, 2 Western.

Deputy Geology Minister Discusses Ecology

907N0108 Kiev PRAVDA UKRAINY
in Russian 12 Feb 90 pp 2-4

[Speech by N. M. Gavrilenko, Deputy Geology Minister of the USSR; response to 12th Session of the Supreme Soviet of the Ukrainian SSR]

[Text] Esteemed comrade deputies: Please allow me to disagree with the opinion expressed here in many speeches that there isn't enough money for ecology. I dare to assure you that, in the opinion of many specialists, there are completely sufficient funds, since losses from not caring for the ecology substantially exceed the amount that we save by failing to spend in this area.

In the opinion of Michael Royston, director of the International Institute of Environmental Management (Switzerland), who recently visited the republic, the loss due to worsening of the ecology is 15-25 percent of the republic's gross national product, and is one of the highest in the world.

And now let's consider what has been reported in the government's report. On the order of 45 billion rubles has been allocated for ecology in the five year plan. Every year the loss of 15 percent of the gross national product is about 15 billion rubles. In five years this figure, even by conservative estimates, will be much higher than projected. The losses are much higher than we need in ecology. We geologists, who are now studying mineral resources, divide the upper polluted zone of rock from what actually exists in natural conditions in order to solve the main problem. We see that over time, the natural conditions in all regions of the republic are changing exceptionally rapidly.

Due to the effect of waste products and refuse, a number of regions, primarily the region of the northern Donets River, Donbass, and Krivbass, are already in such a state that the system will be doomed without the help of man.

The durability of the upper zone of rock is being disturbed by the effect of mining, industrial city development, reclamation, and hydrotechnical construction with the accumulation of large masses of water, which leads to a drastic activation of various very dangerous geological processes. Judge for yourselves. For example, the number of landslides which are now being observed overall in the republic is 11,000. This number has tripled over the last twenty years. There are about 3,000 sink holes in the territory of the republic. Larger territories, almost a million hectares, are flooded, and there the upper zone of rock is wetted, which overall has significantly increased the seismic danger to the territory of the Ukraine. In the majority of the territory the seismicity is 4-5, in some places, up to 7; considering the increase due to wetting of the upper zone of rock, this seismicity increases by 2 or 3, depending on the underlying rock. This creates extremely serious conditions for the economy.

If all changes are combined, 22 percent of the republic can be classified as having strong and very strong fracturing. What can we do? First of all, we have approached the exogenic geological processes, considering the changes in chemical content, and modeled the entire Crimean peninsula. We have created a geological model. This is the largest geological model in the world, the first model where all geological processes, subterranean processes, surface waters, karsts, the rise of ground water, and earth creep, have been modeled on a mathematical base. Here we have drilled 900 wells, and their data is concentrated in this model. The stress condition of the tracts of twenty regions is being observed. As a result of the implementation of this program, in the last 5-7 years, together with the Ministry of Melioration and Water Management and the Academy of Sciences, we have developed and partially implemented measures which have made it possible today to confirm that using a scientific approach these processes can be halted. Now, the levels of the subterranean waters have been reduced everywhere. The quality, apparently, will also be restored in 5-7 years. This process is slower.

Such an approach, such a model has now served as the basis for work in the entire territory of the republic. We have isolated three primary regions, the northern Donets, the Dnieper region, and the Carpathians. Then, we think, overall in five years we will create a model of the geological environment of the republic, and if the government supports it, we will create in Kiev a republic geological and ecological center. It will have all the information needed for examination, for reaching decisions, and for developing measures.

We have now composed a program for this purpose for the next five year plan. The Committee on Ecology of the Supreme Soviet of the USSR has approved this program. The Ministry of Geology of the USSR has also found funds, and has set aside 68 million rubles in the next five year plan. We are conducting such work in the republic as a whole. We are asking the oblasts and cities to propose to enterprises to order from us an ecological large scale photograph around developments. We have now taken photographs in 50 cities. Then it is possible that the condition can be substantially improved with rather simple solutions. Here, for example, in the city of Kiev, in many areas where children gather, pollution by heavy metals is many times higher than the acceptable concentration limit. The surface layer of soil was removed, and grass was planted (this was accepted with architectural plan decisions) and the situation improved somewhat. Many other cities are in the same situation. We are ready to carry out this work. And I would ask the cooperation of enterprises so that this work could be carried out.

The second aspect. You all know quite well the misfortune that struck Gorlovka. Due to leaks at a chemical industrial complex, poisonous substances entered a mine shaft. A large number of miners were injured. Now at all chemical enterprises, including those that pollute the environment, we can drill observation wells. Then the

same thing won't happen. But these enterprises must be forced to carry out the resolutions of the Soviet of Ministers of the USSR on the creation of a secret network of observation wells.

What then can be done to significantly change the attitude toward the use of nature? Primarily economic and legal measures. It must be said that our industry and agricultural industry are somewhat deaf to the many problems of ecology. The problem of obtaining ecologically pure production must be solved. For this production in polluted soil conditions we suggest the use of such nontraditional forms of minerals such as zeolites, glauconites, concrete, saponite, opoka, and sapropel. Use of these materials preserves fertile soils, and significantly reduces the content of harmful chemical substances and even radionuclides in the products.

Globally, these materials are more widely used. In the United States, about 3.5 million tons are used a year. In the Soviet Union, we use 280,000 tons. There are many such deposits in the republic. Some are unexplored. In many cases we are even ready to organize production. Seven foreign firms have turned to us. However, not one agricultural industry in the territory of the republic has come forward as a customer for production or consumption of these very valuable components.

A special problem is the pollution of the environment by mining enterprises. Here there are huge losses. It would be possible to call them that. Seventy percent of explored deposits of oil, up to 40 percent of the coal, and up to 25 percent of the metals remain in the ground. In the extraction of coal, for example, losses due to incomplete excavation per project should be 20 percent. But in Voroshilograd they have risen by a factor of two in the last twenty years, and are now 40 percent. These huge millions of masses are expelled onto the surface, piled up, and ground, polluting everything around them. There are huge losses in the reprocessing of mineral raw materials. Twenty-five percent of the manganese is lost in enrichment. The waste products of the production of the Zaporozhye titanium-manganese industrial complex contain a large amount of rare-metal elements. We can develop technology to enrich them, which makes it possible to reprocess 6,000,000 tons of mineral waste products that metallurgists don't know what to do with now. But until the enterprises order this, they calmly extract only the element they need today.

And look what happens to the waste. Only 3 percent is used. According to a good indicator, 75 percent is used globally. At Kirvorozhye and Donbass we have already accumulated many tens of billions of tons of waste which will pollute the ecology for many years.

I think what has happened today requires a proposal to draft a resolution of the Supreme Soviet to instruct the Soviet of Ministers of the Ukrainian SSR to develop and submit for examination a draft Law on Mineral Resources

Dynamics of Upper Volga Pollution by Meltwater Runoff From Urban Areas

[Article by I. V. Gordin, N. V. Kirpichnikova, S. V. Kirpichnikov and R. A. Lakhtyuk, Water Resources Institute, USSR Academy of Sciences]

[Abstract] A survey was made to ascertain the ecological impact of surface runoff of polluting substances from urban areas. Three spring expeditions were carried out for studying such runoff from Kalinin and its suburbs into the Upper Volga. Due to the daily hydrochemical observations at three points above and below the city it was possible to detect an increased spring concentration of a number of such components as chlorides, sulfates and ammonium nitrogen. The increased concentrations of chlorides in meltwater runoff are not attributable to atmospheric pollution of snow, but instead to the great quantities of salts applied to urban streets. Ammonium nitrogen constitutes the principal form of nitrogen in runoff from urbanized areas. Petroleum pollution from areas above Kalinin is as great as that from the city itself. The survey revealed the feasibility of monitoring anthropogenic pollution of the Volga in this area. The phenomenom of sudden major releases of pollutants into meltwater is noted; this occurs due to such events as sudden thawing of snowbanks and dumping of ponds. These surges are sometimes difficult to register with a sampling interval of one day. Figures 4; references: 12 Russian. j

Empirical Model of Vertical Distribution of Ozone Over Northern Hemisphere

[Article by V. I. Bekoryukov and V. V. Fedorov, candidates of physical and mathematical sciences, and V. N. Glazkov, Central Aerological Observatory]

[Abstract] An empirical model of the vertical distribution of ozone over the northern hemisphere was constructed on the basis of ozone sounding with use of the high correlation between total ozone content and its density in the lower stratosphere and analytical methods for describing meteorological fields. The model is limited to an upward altitude 32 km and a downward altitude 10 km in high and middle latitudes and 16 km in tropical latitudes. Three regions can be distinguished in the considered altitude interval: 1) 10-20 km, where the partial pressure of ozone increases from the equator to the pole and azonality is strongest; 2) 28-32 km, where the partial pressure increases from the pole to the equator and azonality is poorly expressed; 3) 22-26 km,

a transitional region, where the ozone field has a complex structure with relatively small horizontal gradients. In the first region the main maximum of ozone partial pressure during the winter half-year is situated over the northeastern USSR at the same longitude as the maximum of the total ozone content, but considerably northward there is a secondary maximum in northeastern Canada. The minima in the longitudinal variation are situated in the neighborhood of the Greenwich meridian and 120°W. The greatest azonality is in the lowermost layers of the stratosphere during winter and attains a factor of 2. With altitude the azonality sharply decreases and in the region 30 km there is almost total zonality. In the tropics there is a virtually constantly reduced partial pressure of ozone in the India-Philippines region and only at altitudes 30-32 km is it somewhat greater. In summer the azonality of the total ozone content is expressed considerably less. Figures 2; references 11: 8 Russian, 3 Western.

UDC 504.3.054:551.510.534

Influence of Atmospheric Pollution on Measurement of Total Ozone Content

[Article by A. G. Popov, candidate of physical and mathematical sciences, and T. D. Zhukovskaya, Leningrad Hydrometeorological Institute]

[Abstract] The influence of different gaseous pollutants of the atmosphere on the accuracy in measuring total atmospheric ozone content using wide-band filter instruments, such as used in the USSR ozonometric network, is evaluated. Computer-generated nomograms were used in determining total ozone content for different concentrations of SO_2, NO_2, N_2O_5, H_2O_2 and HNO_3 and some other components. Only increased concentrations of SO_2, NO_2 and photochemically forming near-surface ozone can exert a significant influence on the measurement of total ozone content. The errors caused by the highest registered SO_2 and NO_2 concentrations can attain 100 and 40% respectively. For solar altitudes greater than 15° the errors arising during measurements of total ozone content with increased SO_2 and NO_2 are constant for all zenith angles. In making measurements of total ozone content it is necessary to make allowance for and evaluate the possibility of photochemical formation and existence of sources of near-surface ozone because in some cases its content may attain 110% of the natural total ozone content. Other anthropogenic and natural gaseous impurities in the atmosphere exert virtually no influence on measurement of total ozone content with wide-band filter instruments. References 23: 9 Russian, 14 Western.

UDC 551.588.9

Climatic Effects of the Discharge of Smoke Into the Stratosphere

[Article by M. P. Kolomeyev, S. S. Khamelevtsov, S. A. Volovikov, Yu. G. Kaufman, Institute of Experimental Meteorology]

[Abstract] Three months after a large-scale nuclear conflict, aerosol pollution of the stratosphere would be the primary source of the so-called nuclear winter. Many researchers have surmised that the aerosol would consist mainly of basalt-laden dust. According to others, however, the climatic effects and the disruption of the radiation balance would be due less to dust than to smoke carried up to the stratosphere by convective flows over burning cities or by flows originating in the troposphere. The vast differences between the optical characteristics of smoke particulate and those of dust particulate prompted the authors here to study the effects a discharge of smoke into the stratosphere would have on ground surface temperature. Calculations are based on a nonstationary seasonal energy balance model in which the mean surface temperature is computed for nine large zones encompassing the entire earth, as well as on generalized models. It is assumed that a large-scale nuclear conflict discharges 11 megatons of a smoke aerosol consisting of soot particles into the stratosphere. In all latitude zones the smoke aerosol in the stratosphere results in an increase in temperature, with a maximum of a 2.8°C temperature rise occurring in the Arctic zone in July. Figure 1; References 12: 7 Russian, 5 Western.

UDC [551.583:551.345].001.57

Estimation of Influence of Anticipated Climatic Changes on Permafrost Regime

[Article by O. A. Anisimov, candidate of physical and mathematical sciences, State Hydrological Institute]

[Abstract] A model of heat and moisture transfer in the soil-atmosphere system was constructed for a long-range estimate of change in permafrost conditions with a possible change in climate. The model can be represented in the form of two independent blocks. The first is the hydrometeorological regime block, necessary for determining the equilibrium temperature of the surface, by which is meant the snow or soil surface, and the moisture content of the active soil layer. The second is for solving the heat transfer problem in a multilayer

medium with thermophysical parameters and moving fronts of phase transitions, varying with depth. In a general case this is a four-layer medium, consisting of the snow cover and two layers of frozen soil between which there is a thawing layer. A map was constructed showing the results of computations of the cryolithozone in the USSR in which the detachment of permafrost from the layer of seasonal thawing is possible with an increase in mean global air temperature by 1.2 and 2.0°C. With a change by 2°C qualitative transformations of the upper permafrost layer would occur over 15-20% of the area of the USSR cryolithozone now occupied by continuous permafrost with temperature from -1 to -5°C. Figures 2; references 11: 7 Russian, 4 Western.

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